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INSTRUCTION MANUAL

TUNABLE DISCRIMINATOR
MODEL 97D (A, D, or F.)
AND
VARIABLE LOW PASS OUTPUT FILTER
MODEL 95D (A, D, or F.)

B 506

Electro-Mechanical emr Research, inc.
SARASOTA, FLORIDA

INSTRUCTION MANUAL

TUNABLE DISCRIMINATOR

MODEL 97D (A, D, or F,)

AND

VARIABLE LOW PASS OUTPUT FILTER

MODEL 95D (A, D, or F,)

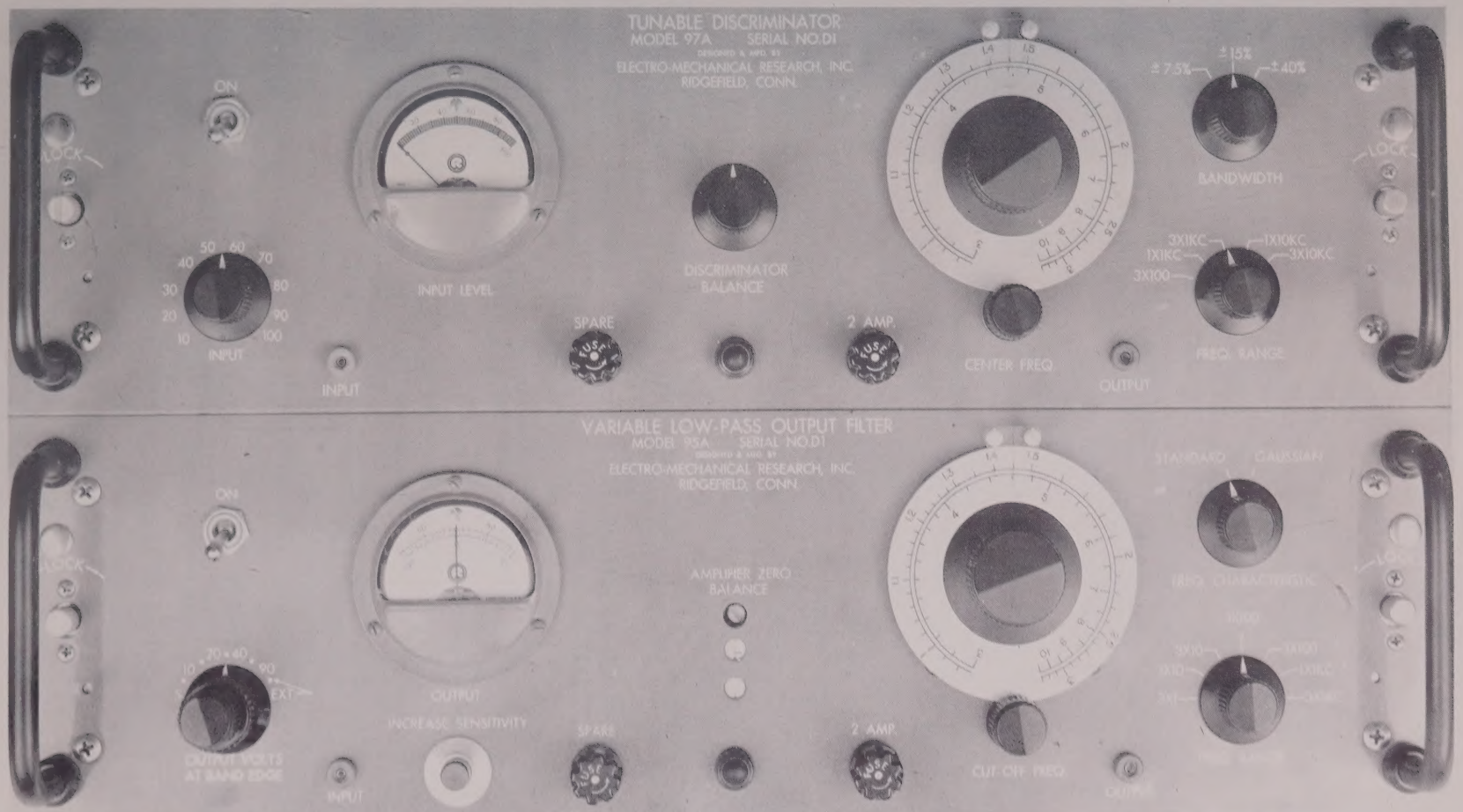
STARTING WITH SERIAL No. 11

ELECTRO-MECHANICAL RESEARCH, INC.

SARASOTA, FLORIDA

SECTION I
TABLE OF CONTENTS

Section	Page
Section I - Table of Contents	I-1
Section II - Photograph of Equipment	II-1
Section III - Description and Installation	
1. General	III-1
2. Characteristics	III-1
3. Installation	III-2
Section IV - Operating Procedure	
1. General	IV-1
2. Input, Output and Power Connections	IV-1
3. Power Source	IV-1
4. Power Switch	IV-1
5. Input Level Control and Meter	IV-1
6. Center Frequency Controls	IV-1
7. Bandwidth Selector	IV-1
8. Input Jack	IV-1
9. Discriminator Balance	IV-2
10. Output Jack	IV-2
11. Magnetic Recorder-Reproducer Tape Speed Error Compensation	IV-2
Section V - Theory of Operation	
1. General	V-1
2. Band-Pass Input Filter	V-1
3. Input Level Meter	V-1
4. Limiter and Pulse Generator	V-1
5. Trigger Circuit Discriminator	V-1
6. Ratio Detector and Output Stage	V-2
7. Power Supply	V-2
Section VI - Maintenance	
1. Inspection	VI-1
2. Voltage Measurements	VI-1
3. Performance Tests	VI-1
Section VII - Tables and Drawings	VII-1
1. Block and Waveform Diagram	Fig. VII-2
2. Interconnections - Model 97 and Model 95	Fig. VII-3
3. Location of Components - Top View	Fig. VII-4
4. Location of Components - Bottom View	Fig. VII-5
5. Tube Socket Voltages	Fig. VII-6
6. Band-Pass Input Filter Attenuation Characteristics	Fig. VII-7
7. Model 97 Circuit Diagrams	Fig. VII-8 A D F
8. Model 97 Parts List	Fig. VII-9 to VII-15



Model 97 and Model 95 Equipment

SECTION III
DESCRIPTION AND INSTALLATION

1. GENERAL

The TUNABLE DISCRIMINATOR, MODEL 97 is used to isolate any given subcarrier in the 300 cps to 100 Kc range and to discriminate the frequency modulation on this subcarrier. Complete removal of the subcarrier signal from the modulation is effected by the EMR VARIABLE LOW-PASS OUTPUT FILTER, MODEL 95, which is designed for use with the MODEL 97.

Except for their tunable feature, the combination of Models 97 and 95 operates similarly to the EMR SUBCARRIER DISCRIMINATOR, MODEL 67, and they provide most of the features of this equipment.

The Model 97 Discriminator provides theoretically perfect linearity of discrimination. Zero drift is minimized. Base line limiting of the subcarrier eliminates amplitude modulation effects and reduces step function changes normally encountered in magnetic tape drop-outs to a minimum.

Separation of the desired subcarrier is achieved by a tunable two-pole band-pass input filter whose characteristics have been designed to keep the time delay of intelligence constant throughout the pass band. Bandwidths of both ±7.5% and ±15% of center frequency are provided over the entire range from 300 cps to 100Kc. For special cases where deviation up to ±40% is required, a flat amplifier is substituted for the band-pass filter.

Because of the constant time-delay characteristics of the input filter, provisions have been made for speed-change compensation of tape recorded data.

2. CHARACTERISTICS

The EMR TUNABLE DISCRIMINATOR, MODEL 97 is designed for use with the EMR VARIABLE LOW-PASS OUTPUT FILTER, MODEL 95. Specification to be given here include the use of both units as a system.

SUBCARRIER FREQUENCY RANGE:
Center frequency continuously tunable from 300 cps to 100 Kc.

SUBCARRIER FREQUENCY DEVIATION:
Both ±7.5% and ±15% of center frequency are included. Input filter may be switched out for use with a single subcarrier having deviation up to ±40%.

INTELLIGENCE FREQUENCY:
Upper cut-off frequency is continuously adjustable from 3 cps to 10.5 Kc on the VARIABLE LOW-PASS OUTPUT FILTER, MODEL 95.

REJECTION OF UNWANTED SIGNALS:
The action of the discriminator circuit exclusive of the bandpass input filter is to reject completely any modulation appearing on a second carrier superimposed on the desired subcarrier if the amplitude of the unwanted is less than 90% of the other. In addition, the LOW-PASS OUTPUT FILTER, MODEL 95, rejects beat frequencies between subcarriers which occur above its cut-off point. To these characteristics may be added the attenuation of the input filter in determining the rejection of modulation appearing on an adjacent channel carrier (See Sect. VII, Fig. 6). With the 7.5% filter, rejection of modulation appearing on an adjacent carrier 6 db larger than the desired carrier is more than 60 db.

TIME DELAY OF INPUT FILTER:
With ±7.5% deviation, delay is equivalent to approximately 2 cycles of subcarrier center frequency. With ±15% deviation the delay is one half of the value for ±7.5%. Total variation of time delay within each pass band does not exceed ±2.5° of intelligence cut-off frequency based upon a modulation index of 5. This value of variation is inversely proportional to modulation index.

HARMONIC DISTORTION:
The MODELS 97 and 95 reduce data with a harmonic distortion of less than 1% for all intelligence frequencies up to channel cut-off.

INPUT IMPEDANCE:
The input impedance is 0.5 megohms shunted by 20 mmf.

INPUT SIGNAL RANGE:
A minimum signal level of approximately 10 millivolts is required. Larger inputs are controlled with the input potentiometer. The dynamic range of operation above a minimum signal is greater than 30 db.

AMPLITUDE MODULATION AND TAPE DROP-OUT:

With the discriminator equipped for operation at a modulation index of 5, 50% square wave amplitude modulation of the subcarrier results in a change in output amplitude equivalent to less than 1% of bandwidth. This effect increases proportionately as modulation index is decreased.

OUTPUT FILTER: (MODEL 95)

The cut-off frequency of the VARIABLE LOW-PASS OUTPUT FILTER, MODEL 95, may be tuned continuously from 3 cps to 10.5 Kc. in seven ranges. Either a response flat to ±0.5 db below cut-off or a Gaussian roll-off may be obtained. Above the cut-off frequency attenuation is at the rate of 36 db per octave. See the Instruction Manual for the MODEL 95 for representative attenuation curves, and further details.

The output circuit is single ended and is referred to ground. The output level for subcarrier deviation of full design bandwidth is continuously-adjustable from ±5 volts peak to ±90 volts peak. The current capability of the output circuit is ±25 ma. peak. Its output impedance is less than 10 ohms.

ZERO SIGNAL PROTECTION:

In the event that subcarrier is removed, discriminator output is zero.

LINEARITY OF OUTPUT VS. SUBCARRIER FREQUENCY:

Linearity is ±0.2% of full bandwidth based on best straight line.

AUTOMATIC CALIBRATION: (MODEL 95)

Provision is made for introduction of an external zero and for external control of the output amplifier gain.

OUTPUT STABILITY:

Stability is ±0.5% of full bandwidth in a 15-hour period after a 15-minute warmup.

SENSITIVITY STABILITY:

Stable within ±0.25% of bandwidth.

MAXIMUM OUTPUT NOISE: (MODEL 95)

Less than 0.1% of bandwidth with output filter set for maximum cut-off frequency.

POWER REQUIRED:

105-125 volts, 60 cps.
Model 97 : 175 watts
Model 95 : 190 watts

PANEL SIZE:

Model 97 and Model 95 : 5 1/4" x 19"
(Same as Model 67)

CHASSIS SIZE:

Model 97 and Model 95 : 16 3/8" wide by 16 1/8" deep.
(Same as Model 67)

DEPTH BEHIND PANEL:

Model 97 and Model 95 : 16 3/8" maximum
(Same as Model 67)

WEIGHT:

Model 97 : 49 lbs.
Model 95 : 47 lbs.

PANEL FINISH:

EMR Light Umber Gray

3. INSTALLATION

The Model 97 Discriminator has been designed for standard rack mounting with or without slides. If pullout, non-turnover slides are required, brackets have been included on the discriminator sides for the addition of Grant Pulley and Hardware Co. slides. To slide mount the discriminator, the slides previously assembled in the rack should be fully withdrawn from the rack and the discriminator placed on the slides so that the discriminator brackets support the discriminator on the slides. The bracket should be secured to the slides with the screws provided. To slide the discriminator into the rack, release the stops by depressing the levers on the top of each slide.

When slides are not used, the discriminator may be mounted in the rack by providing brackets in the rack for supporting the discriminator on the brackets included on the sides of the unit.

In either case, the discriminator is held in the rack by means of lock fasteners on each side of the front panel.

The open center section of the discriminator chassis, into which all tubes and other heat producing components project, permits efficient cooling of the discriminator. The airstream of a rack ventilator may be directed through the duct formed by the center section of several discriminators mounted in a rack.

SECTION IV
OPERATING PROCEDURE

1. GENERAL

The EMR TUNABLE DISCRIMINATOR, MODEL 97, is designed for use with the EMR VARIABLE LOW-PASS OUTPUT FILTER, MODEL 95. Together these units provide the ultimate in flexibility in demodulating frequency-modulated subcarriers.

Connections between the MODEL 97 and 95 will be described in this section, as well as the Operating Procedure for the MODEL 97. Operation of the MODEL 95 is discussed in the Manual for that unit.

The location of controls on both units is shown by the Photograph of Fig. II-1.

2. INPUT, OUTPUT, AND POWER CONNECTIONS (MODELS 97 and 95)

Connections are made to Cannon Receptacles located at the rear of each unit, in accordance with Fig. VII-2. Cannon Plug No. DPD-D32C2-33S-1L inserts in both receptacles. Note that both positive and negative B supplies from the 95 are used in the 97 (For the input filter).

3. POWER SOURCE

MODELS 97 and 95 operate on 115 volt 60 cps single phase power.

4. POWER SWITCH

For operation of the MODEL 97, both the power switches on the 97 and the 95 must be turned on, since the power supply of the 95 supplies the B power for the band-pass filter in the 97. No damage will be done if either unit is on alone, however.

5. INPUT LEVEL CONTROL AND METER

Input potentiometer R101 located on the front panel permits attenuation of large input signals to an optimum operating range for the band-pass input filter. This range is indicated by the green area of the INPUT LEVEL meter. An input signal of 10 millivolts rms will produce proper discriminator operation, although with such signals the input level may be below the green area. If any amplitude variation of the signal is expected it is preferable to operate near the middle of the green area. Blocking of the input filter occurs near the top of the meter scale. Dynamic range of operation is greater than 30 db.

Note that the INPUT LEVEL meter is connected at the output of the band-pass input filter, so that only the desired subcarrier will be monitored. The signal level may be monitored remotely by connecting a 0-200 microammeter at Pins 5 and 6 on the Cannon rear chassis connector. A jumper must be placed across these pins when the external meter is not used.

6. CENTER FREQUENCY CONTROLS

Choice of the subcarrier center frequency is made with the MODEL 97 by the FREQUENCY RANGE knob and the associated CENTER FREQUENCY dial located at the right of the front panel. Markings on the FREQUENCY RANGE knob indicate which scale of the dial shall be read as well as the proper multiplier. For example, 3 x 100 indicates the scale which is graduated from 3 to 10, with a lowest frequency available of 300 cps center frequency. The unit shown in Fig. II-1 is set for about 4600 cps.

In tuning to a fixed signal the filter may be centered by observation of the INPUT LEVEL meter while rotating the CENTER FREQUENCY vernier knob.

7. BANDWIDTH SELECTOR

Located at the upper right of the front panel, the BANDWIDTH knob selects a band-pass input filter characteristic of ±7.5% or ±15% of center frequency (See Fig. VII-6). In the ±40% position a flat amplifier is substituted for the filter. The gain in each position is adjusted so that ordinarily no level changes in the INPUT control need be made when the BANDWIDTH control is switched.

The bandwidth selector simultaneously adjusts the output level of the discriminator circuit so that it is constant for the full deviation as shown.

8. INPUT JACK

The INPUT jack located at the lower left of the front panel provides for observation of the

output of the band-pass filter on an oscilloscope. This test point is connected in the INPUT LEVEL meter circuit, so it is not a measure of the absolute output level at the filter. For a ground connection use any convenient spot on the chassis.

The INPUT jack is also connected internally to Pin 27 of the rear receptacle.

9. DISCRIMINATOR BALANCE

This knob at the center of the front panel operates a 10-turn potentiometer, R320, which is a vernier adjustment of the tuning of the discriminator circuit of the Model 97. Since the coarse adjustment of the discriminator is automatic upon alignment of the band-pass input filter, a sensitive adjustment is required to achieve exactly centered output to the Model 95. Centering of the DISCRIMINATOR BALANCE control results in a square waveform out of the discriminator with no dc component, as read on a voltmeter or on the OUTPUT meter of the MODEL 95, when that unit is properly adjusted.

10. OUTPUT JACK

The OUTPUT jack carries a sample of the square waveform at the output of the MODEL 97, with a peak to peak amplitude of 1 volt. It may be observed on an oscilloscope of suitable bandwidth.

11. MAGNETIC RECORDER-REPRODUCER TAPE SPEED ERROR COMPENSATION

The discriminator timing circuit is returned to Pin 22 of the rear receptacle. For normal operation without compensation, this point must be connected to ground. (Pin 15, etc.). When Magnetic Tape Speed Error Compensation is to be applied, this pin should be removed from ground and connected to the output point of the compensation system.

SECTION V
THEORY OF OPERATION

1. GENERAL

The EMR TUNABLE DISCRIMINATOR, MODEL 97, consists of a band pass input filter, limiter, pulse generator, trigger circuit frequency discriminator, and a ratio detector and output stage. It is designed for use with the EMR VARIABLE LOW-PASS OUTPUT FILTER, MODEL 95. A block and waveform diagram of these units is shown by Fig. VII-1. The circuit diagram of the MODEL 97 is shown by Fig. VII-7.

The input impedance of the band-pass input filter is 500K ohms, so that a large number of units on different channels may be paralleled.

2. BAND-PASS INPUT FILTER

The band-pass input filter consists of two electronic filter networks forming a two-pole filter characteristic. Resonant properties of these networks are obtained from bridged-T networks composed of fixed precision capacitors and ganged variable resistors. Separate banks of capacitors are used for ±7.5% deviation or ±15% bandwidth. Representative attenuation curves for these filters are shown by Fig. VII-6.

3. INPUT LEVEL METER

The signal from the output of the band-pass input filter is applied through a dropping resistor, R-200, to the rectifier bridge circuit formed by diodes D-101 and D-102 and resistors R-219 and R-220.

4. LIMITER AND PULSE GENERATOR

The output of the band pass filter is applied to the limiter stage, V-201, V-202, V-203, which presents a square wave to the pulse-forming stage, V-301. This stage triggers the discriminator at the plate of V-302.

The limiter circuit V-201, V-202, V-203, is designed to produce a square wave whose positive excursion occurs simultaneously with the input sine wave zero axis crossing in the positive-going direction. The amplifier V-201 is designed to provide a large amplification of the input signal sine wave for plate excursions of approximately ±20 volts. Beyond this plate excursion range one of the diodes of V-202 conducts and reduces the gain of amplifier V-201 to approximately unity, thus preventing any further large plate excursions. Thus, for limiting sine wave signals, the signal on the plate V-201 approximates a square wave whose sides coincide with the zero axis crossing of the input sine wave. This approximate square wave then triggers the cathode coupled bistable multivibrator V-203. The output of this trigger circuit is selected from the unloaded plate of V-203B, which because of the cathode coupling is free of capacity and therefore produces a good square wave.

Because this limiter circuit triggers only when the incoming sine wave crosses the zero axis, the output will be unaffected by variations in input signal levels over the entire linear range of the band-pass input filter. Since limiting occurs with between 0.4 and 1.0 volts rms on the cathode of V-153A, and this filter output remains linear to at least 35 volts rms, a dynamic input operating range of greater than 30 db is provided. This permits the limiter to reject large scale amplitude modulation almost completely. When the input signal to the grid of V-101 falls below approximately 10 millivolts limiting will fail and the discriminator will become inoperative.

The output of the limiter is fed to V-301 through the pulse forming circuit C-209 and R-301. V-301 is biased beyond cutoff so that the negative grid pulses do not appear at the discriminator. Each positive grid pulse triggers the discriminator through the plate coupling of V-302.

5. TRIGGER CIRCUIT DISCRIMINATOR

The circuits associated with V-302, V-303, and V-304 constitute the frequency discriminator. This circuit produces a rectangular wave swinging between +100 volts DC and -100 volts DC whose total period is equal to the subcarrier period but whose positive portion is timed by networks in the discriminator. The result is a varying DC component in the rectangular wave which has an exact linear relationship to the instantaneous subcarrier frequency.

In the absence of pulses from V-301, the discriminator circuit is inoperative, with V-302 cut off, and V-304 conducting by virtue of their respective grid and cathode return circuits. In

this condition, the diode V-303A conducts and the plate voltage of V-302 is fixed at approximately +100 volts through the resistance divider R-307, R-310 and R-311. This condition also maintains the cathode of V-303B at +100 volts. The circuit passes through one cycle of operation for each trigger pulse from V-301, the pulse being applied directly to the plate of V-302 and through diode V-303A, cathode follower V-303B and the discriminator tuning capacitor, C-182 to C-186, to the control grid of V-304. The amplitude of the pulse applied to the grid of V-304 is maintained constant because diode V-303A ceases conduction after the plate of V-302 becomes more negative than -100 volts. With V-304 thus cut off, its plate rises to approximately 160 volts applying positive grid bias to V-302 through R-309. In this conducting condition the plate of V-302 falls to approximately -170 volts while the cathode of the diode V-303A is maintained at approximately -100 volts by R-310 and R-311. This also maintains the cathode of the cathode follower V-303B at approximately -100 volts. In this manner, the circuit will remain in this condition for a specific constant time until the discriminator timing network discharges sufficiently to start conduction of V-304. The circuit then returns abruptly to the initial condition where it awaits the next pulse of V-301. Thus the ±100 volts on the cathode of V-303B corresponding to the two discriminator circuits conditions is dependent only on the precision of resistors R-307, R-310, R-311 and the stable B+ and B- voltages, and not upon the conduction characteristics of the tubes V-302 or V-304. Since V-301 and V-302 are completely cut off before a trigger pulse these tubes do not affect the +100 volt condition of the cathode follower V-303B.

Resistor R-320 provides an adjustment of the output at center frequency since it affects the time constant during which V-304 is saturated and V-302 is cut off, following each trigger pulse. This resistor is referred to as the DISCRIMINATOR BALANCE CONTROL.

6. RATIO DETECTOR AND OUTPUT STAGE

Because removal of subcarrier results in the discriminator clamping at +100 volts, the output circuit of the MODEL 97 has been isolated from this circuit by a ratio detector, V305, which passes the rectangular waves intact, as well as their DC component, but which returns to zero if subcarrier is removed. A pair of cathode followers, V-306, provide a low output impedance for the input to the VARIABLE LOW-PASS OUTPUT FILTER, MODEL 95.

7. POWER SUPPLY

The B- supply is electronically regulated by V-5, V-6 and V-3B. V-5 supplies a fixed reference voltage for the regulator amplifier V-6 and V-3B. V-3B acts as the current regulator for the B- supply. The ripple content of the supply is extremely low due to a special bridge balance circuit incorporated in the screen circuit of V-6B. Resistors R-21, R-22, R-24, R-23 and capacitor C-11 constitute this bridge circuit. This design achieves a null in the ripple voltage of the B- supply.

The B+ supply is similar to the B- with the exception that it is referenced from the B- supply. V-5 supplies the reference for the B+ supply and the cathode of V-4A is returned through R-3 to the B- supply. The ripple voltage of the B+ supply is nulled through the resistance divider network R-7, R-8 and R-9 located in the screen circuit of V-4B. The filaments of both V-4 and V-6 are regulated to further increase the stability of the B+ and B- supplies.

SECTION VI
MAINTENANCE

1. INSPECTION

The EMR TUNABLE DISCRIMINATOR, MODEL 97, should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. A visual inspection should be made each week, checking for loose components and evidence of overheating; and a complete inspection every six months should include the following:

a. Test all vacuum tubes.

b. Tighten all screws.

c. Inspect wiring for loose connections and evidence of overheating.

d. Check all tube socket voltages.

e. Check performance.

f. Replace defective components.

2. VOLTAGE MEASUREMENTS

All DC and AC voltage measurements may be made using the chassis ground as a reference. Tube socket voltages are given in Section VII. Fig. VII-6.

3. PERFORMANCE TESTS

The performance of the Discriminator may be checked by performing the tests described below. The inspection record may be used in connection with these tests. An audio frequency oscillator, vacuum tube RMS voltmeter, input attenuator, oscilloscope, accurate means for measuring 0 to 30 d-c milliamperes and 0 to 100 volts dc and equipment to measure frequency to within 0.02% should be used in conducting these tests. The set should be placed in accordance with the conditions and the procedure outlined under Installation and Operating Procedure.

The physical layout including tubes and component cards is shown on drawings in Section VII, Tables & Drawings Fig. VII-4 and Fig. VII-5 ,

a. BAND PASS INPUT FILTER GAIN AND FREQUENCY CHARACTERISTICS.

The output of the band pass input filter may be measured at Pin 3 of V-153A, using a high-impedance probe with a capacity less than 15 μμf. The output of the first filter section appears at Pin 8 of V-103A. For a typical attenuation curve, see Fig. VII-7.

The gain of the band pass filter at center frequency is approximately 100. Each section has a gain of about 30, however, there is an attenuator between sections having a ratio of 10:1

b. LIMITER OPERATION

The output of the limiter may be observed at Pin 2 of V-203. It should have the form of a rectangular wave swinging between +70 and +200 volts. Some limiting action is provided by the combination of amplifier V-201 and diodes V-202. The waveform of this combination appears at Pin 5 of V-201. As input signal is increased, the top and bottom of the output are flattened. The level of the top is approximately +120 volts, the level of the bottom +80 volts.

c. DISCRIMINATOR OUTPUT

The output of the discriminator can be observed at Pin 8 of V303B. When this circuit is in operation its signal will be a rectangular wave swinging between approximately -100 volts and +100 volts. When input signal is removed the voltage at this point remains fixed at +100 volts.

The timing wave of the discriminator is applied at Pin 1 of V304. The timing pulse swings negative from a level of -200 volts to -400 volts, and V304 is cut off. When the timing circuit has returned Pin 1 to -200 volts, V304 conducts and the timing period is completed.

d. RATIO DETECTOR AND OUTPUT STAGE

The ratio detector preserves the discriminator waveform about a d-c level which is determined by potentiometer R-322. This potentiometer is normally adjusted so that the out-

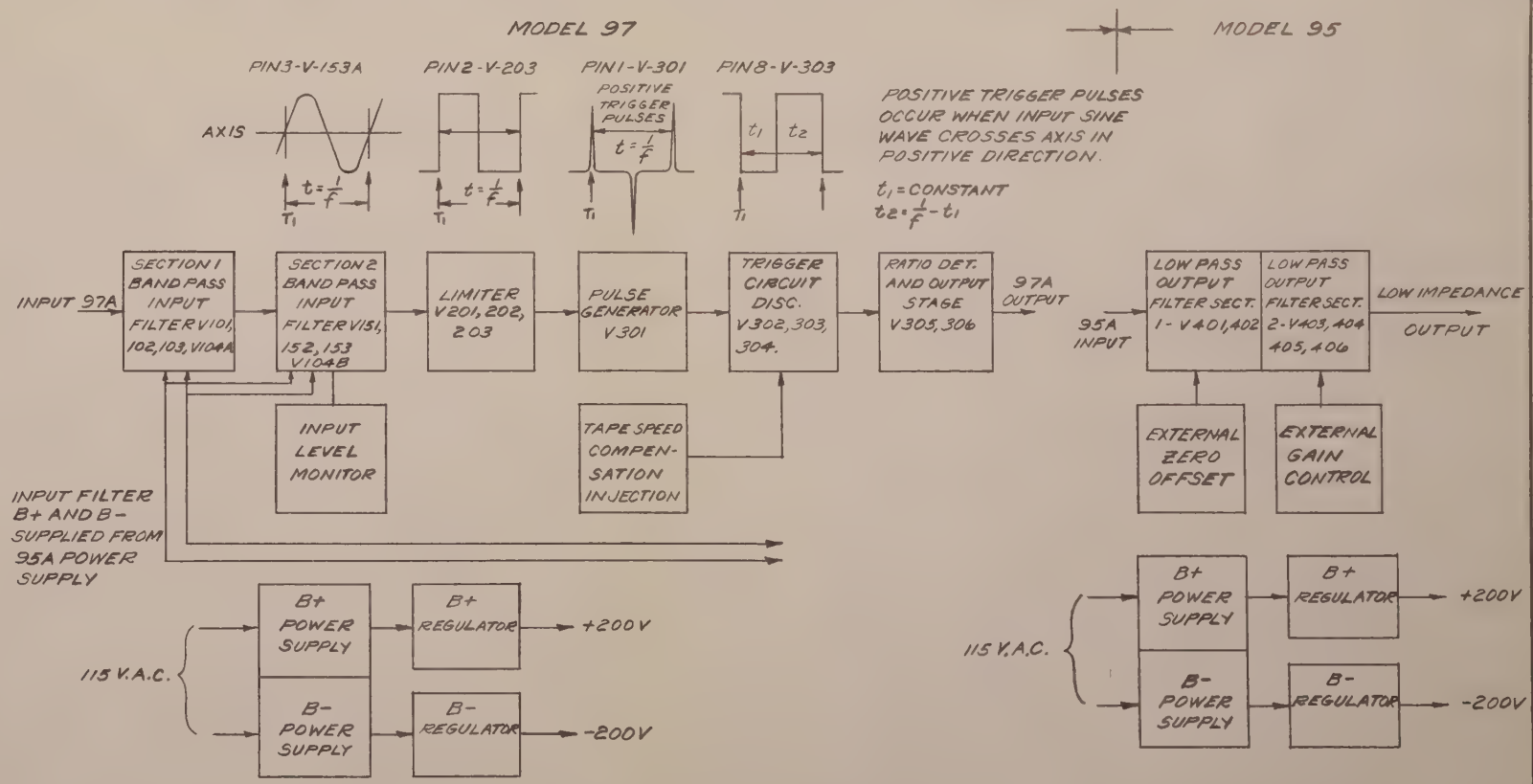
put of the Model 97 is zero with no input signal. It is a miniature locking potentiometer with a screw-driver adjustment, located on the chassis between the rows of tubes. Adjustment of R-322 will ordinarily be necessary only when V306 is changed.

e. POWER SUPPLY

The B+ and B- power supply voltages may be observed at capacitors C13 and C14, respectively. These capacitors are mounted on the discriminator chassis. The B+ and B- voltages should be between 190 and 210 volts. The ripple voltage on either should be less than 4 millivolts RMS. If the ripple voltage exceeds this figure, V-4 or V-6 should be changed.

The regulation of the regulated heater windings of the power transformer should be within ±1% and ±0.5% for a range of input voltage from 105 to 125 volts, 60 cps, as noted on the circuit schematic.

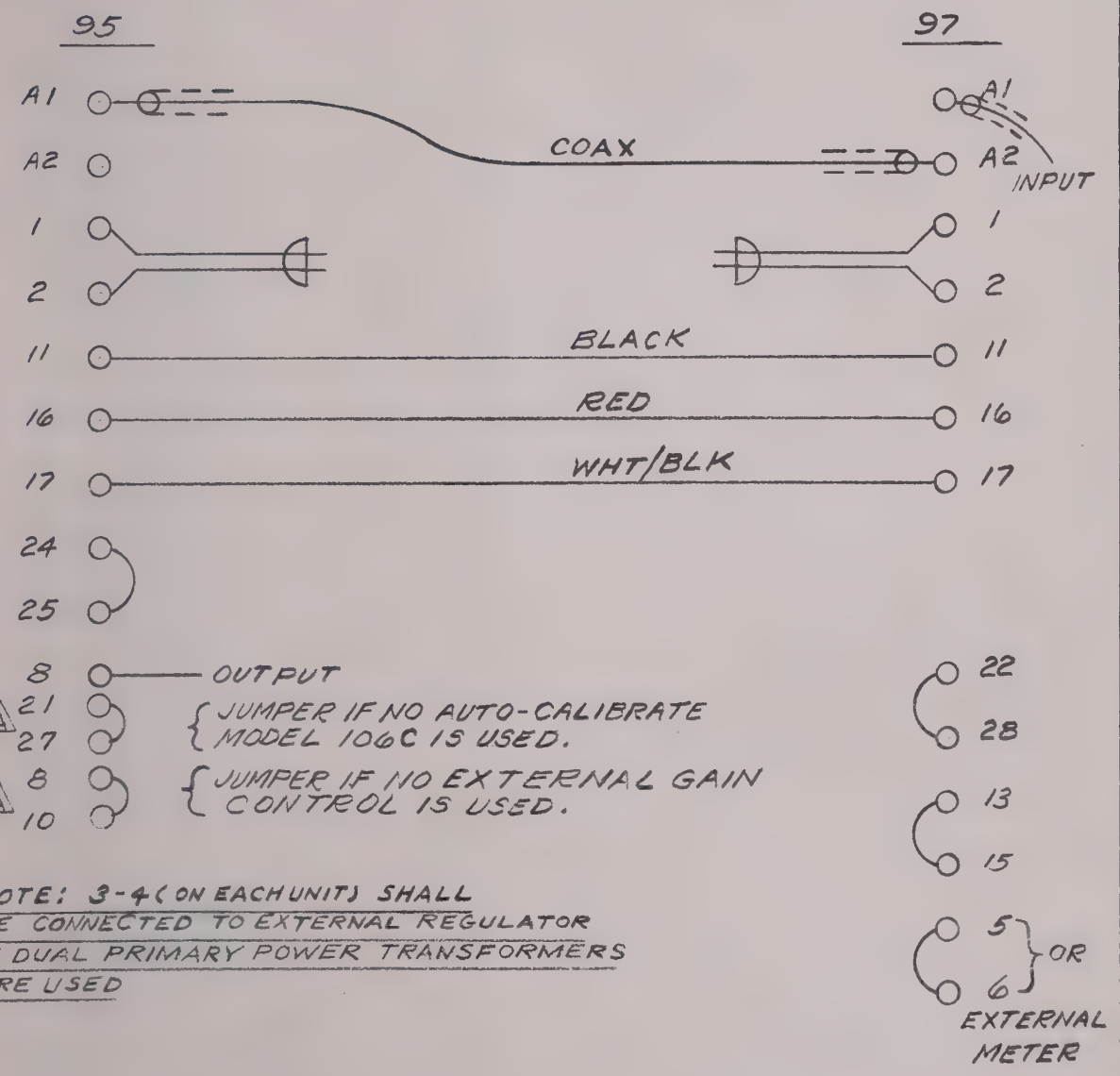
SECTION VII
TABLES AND DRAWINGS



DO NOT SCALE DRAWING ALL FRACTIONAL HOLES +1/64–0

J		E		DATE 2-17-56	ELECTRO-MECHANICAL RESEARCH INC. RIDGEFIELD, CONNECTICUT	
I		D		SCALE		
H		C		DRAWN HB	MAT'L.	TOL. UNLESS NOTED
G		B		CKD. RC	FINISH	FRACTIONAL ± 1/64
F		A		APP. G.E.T.		DECIMAL ± .005
REVISIONS				NO. REQ'D.	BLOCK & WAVEFORM DIAGRAM	
					97 & 95	B-02154

Fig. VII-2



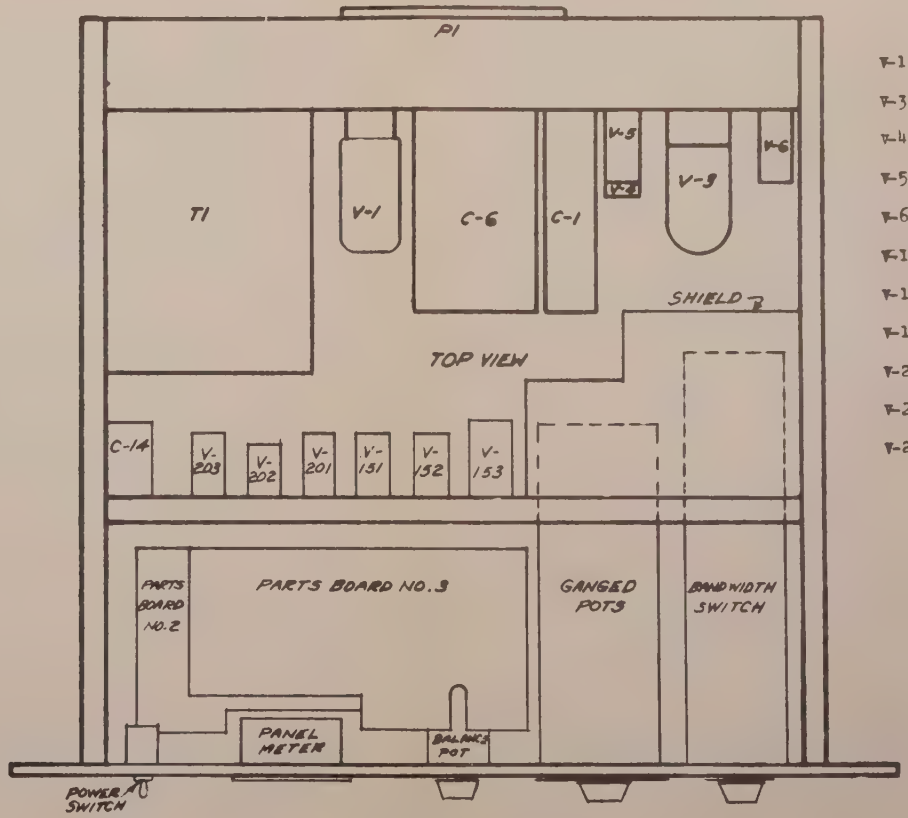
NOTE: 3-4 (ON EACH UNIT) SHALL BE CONNECTED TO EXTERNAL REGULATOR IF DUAL PRIMARY POWER TRANSFORMERS ARE USED

DO NOT SCALE DRAWING ALL FRACTIONAL HOLES +1/64—0

J		E		DATE 2-17-56	ELECTRO-MECHANICAL RESEARCH INC. RIDGEFIELD, CONNECTICUT		
I		D		SCALE ~			
H		C		DRAWN HB	MAT'L. ~	TOL. UNLESS NOTED	
G		B		CKD.	FINISH ~	FRACTIONAL ± 1/64	
F		A	ECN 775, #21, 27, 8, 10, ADD NOTES ADDED. 7-15-58 HB	APP. G.E.T.		DECIMAL ± .005	
REVISIONS				NO. REQ'D. ~	INTERCONNECTIONS 95 97		A-02156

Eugene Dietzgen Co., Inc., New York, N. Y. No. 196M Ageproof Tracing Vellum

Fig. VII-3



V-1	-	5Y4GA
V-3	-	6080
V-4	-	6AW8
V-5	-	5651
V-6	-	6AW8
V-151	-	6176
V-152	-	6176
V-153	-	6201
V-201	-	6AU6
V-202	-	6AL5
V-203	-	5964

DO NOT SCALE DRAWING

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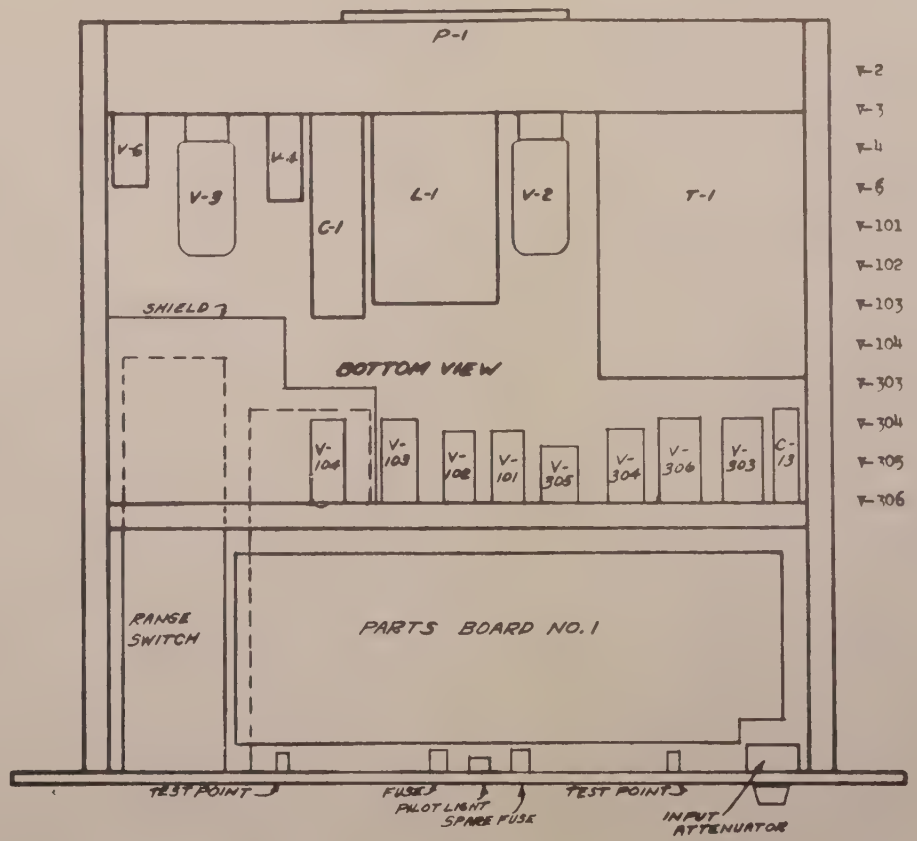
I		D		SCALE	
H		C		DRAWN R.P.	MAT'L.
G		B		CKD. HB	FINISH
F		A		APP'D [illegible]	LOCATION OF COMPONENTS
REVISIONS				NO. REQ'D.	97 B-02152

Fig. VII-4



V-2	–	5Y3GA
V-3	–	6080
V-4	–	6AW8
V-5	–	6AW8
V-101	–	6136
V-102	–	6136
V-103	–	6201
V-104	–	6201
V-303	–	6BK7A
V-304	–	6136
V-305	–	6AL5
V-306	–	6BK7A

DO NOT SCALE DRAWING

J		E		DATE 1-25-58	ELECTRO-MECHANICAL RESEARCH INC.		
I		D		SCALE	RIDGEFIELD, CONNECTICUT		
H		C		DRAWN HB	MAT'L	TOL. UNLESS NOTED	
G		B		CKD. HB	FINISH	FRACTIONAL ± 1/64	
F		A		APP. W.L.H.	LOCATION OF COMPONENTS	DECIMAL ± .005	
REVISIONS				NO. REQ'D.	97	B-02153	

Fig. VII-5

TUBE SOCKET VOLTAGES
TYPICAL DC VOLTAGES
MODEL 97

Pin Numbers

Tube	1	2	3	4	5	6	7	8	9
V1	0	+350	0		0		0	+350	
V2	0	+117	0		0		0	+115	
V3	+150	+350	+200	-22	+90	0			
V4	-110	-111	-4			0	-4	+110	+142
V5	-111	-200		-200	-111		-200		
V6	-110	-111	-88			-85	-88	-60	-22
V101	-5.6	-5.3			+42	+44	-5.		
V102	-190	-190			-100	-130	-100		
V103	+195	0	+2.7			+195	-100	-100	
V104	+195	-110	-108			+195	-100	-95	
V151	-5.2	-5.			+45	+50	-4.4		
V152	-190	-190			-115	-140	-190		
V153	+190	-115	-115			+190	0	+3.4	
V201	-2.6	0			+105	+195	0		
V202	+16	-23			-3.5	-4.4	-3.5		
V203	+136	+136			+12.	+8	+21		
V301	-200	-190			-35	0	-190		
V302	-190	-180			-35	-70	-180		
V303	-35	-35	-6.5			+185	-6.5	-1.7	
V304	-240	-200			-38	-150	-200		
V305	+95	-90			- 4.8		-4.8		
V306	+186	-4.8	- .44			+190	-4.8	- .44	

AC Volts

V-1		310		310	
V-2		375		375	

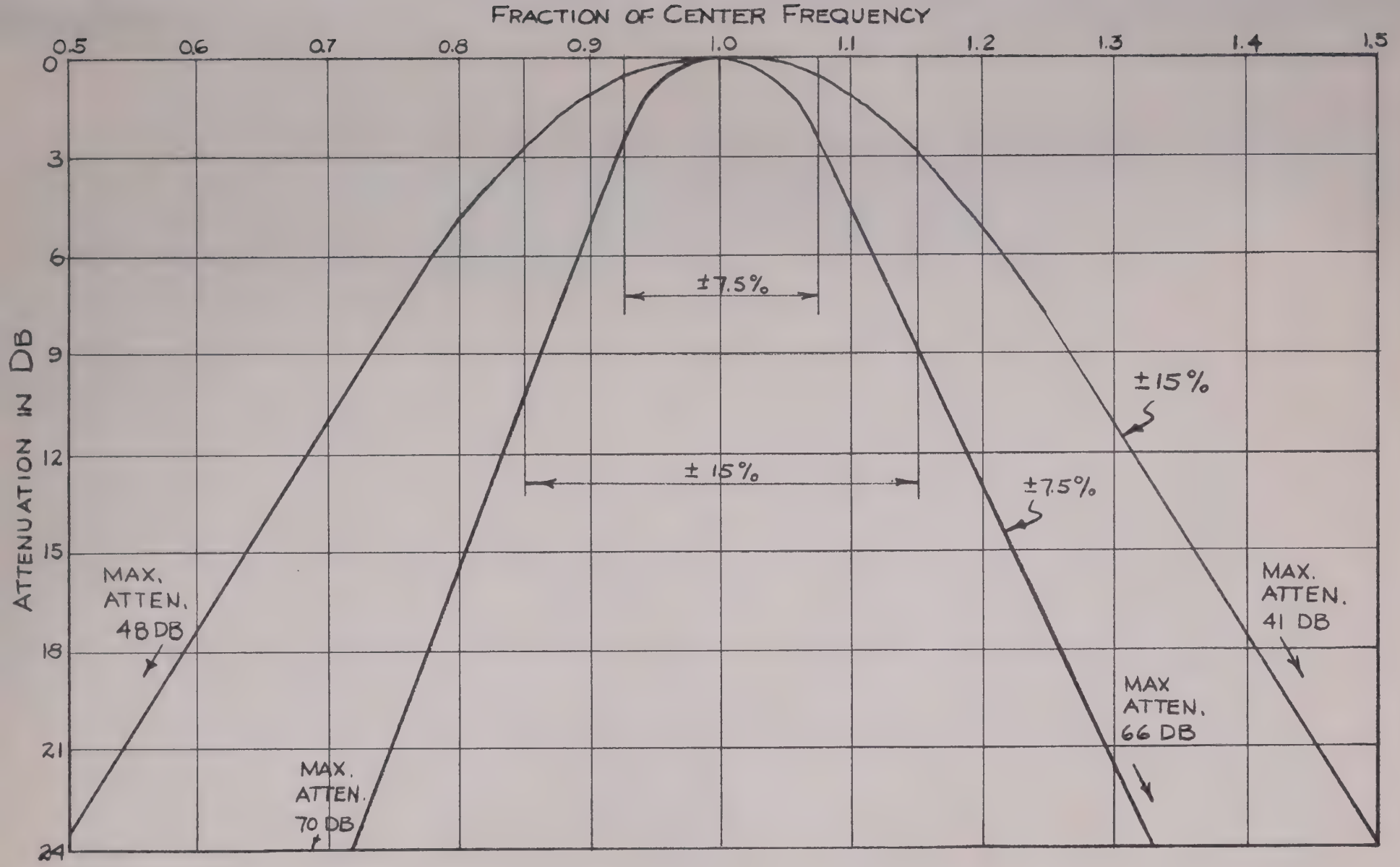


FIG. VII-7 Band-Pass Input Filter Attenuation Characteristics

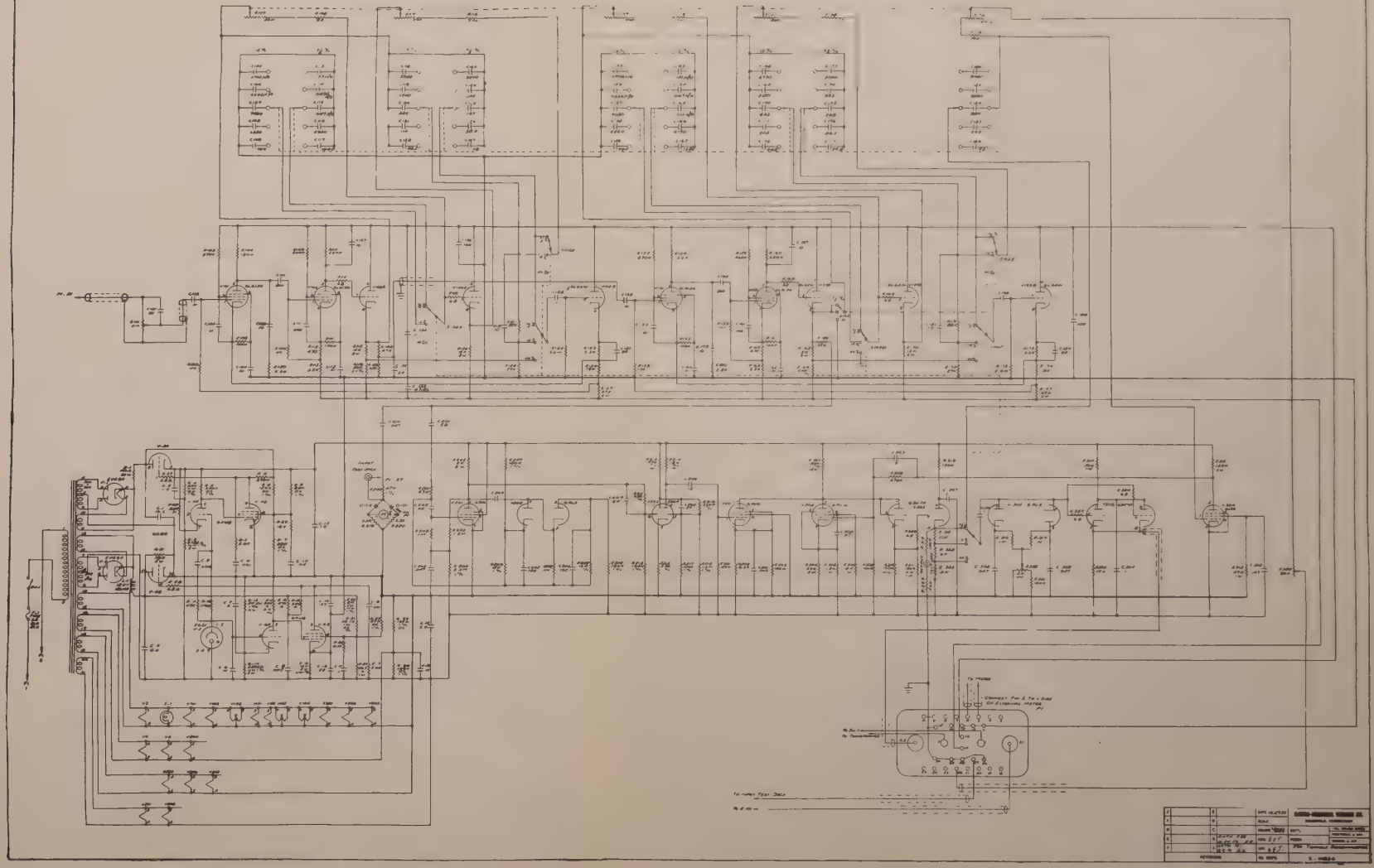


Fig. VII-8 A

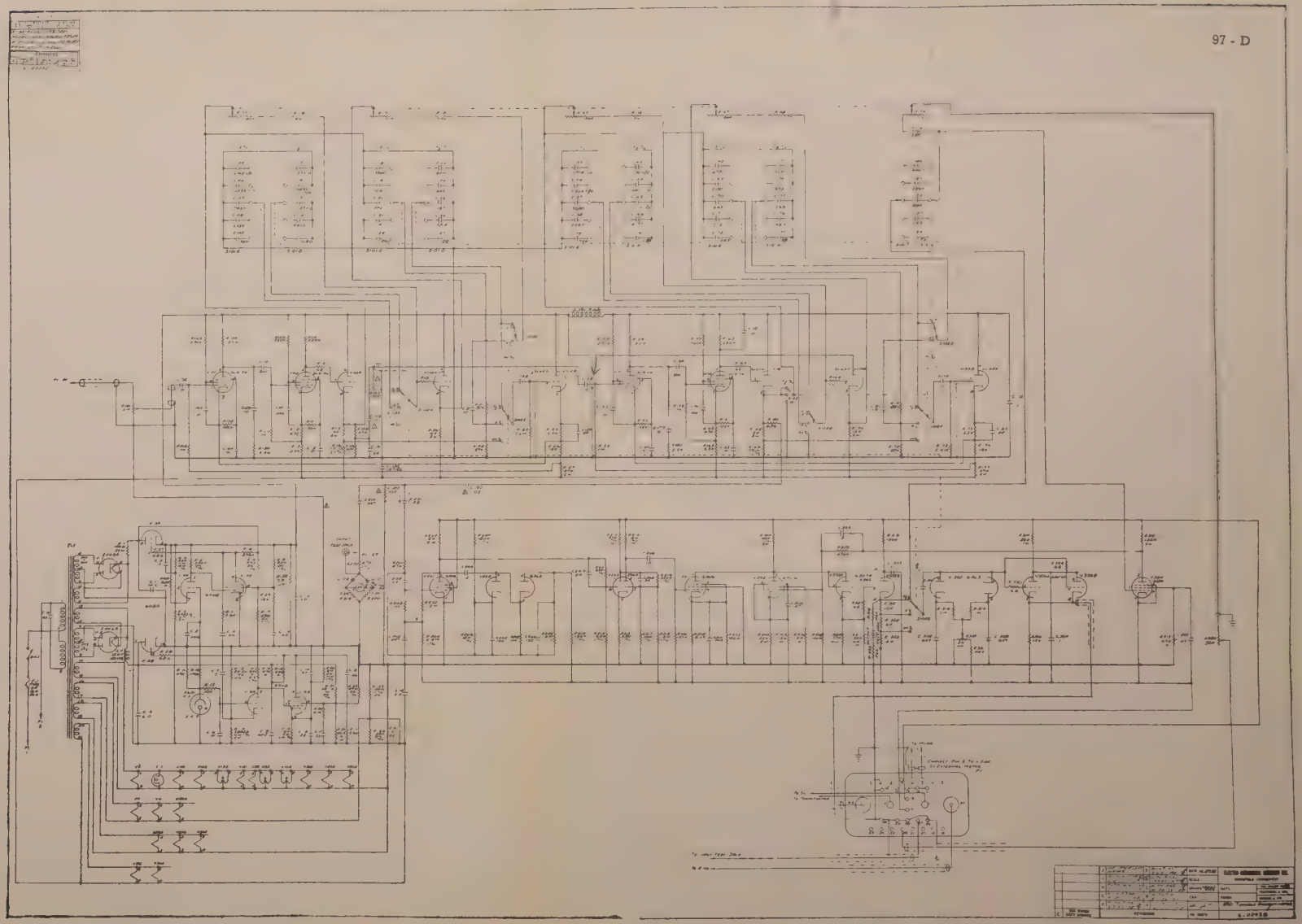


Fig. VII-8 D

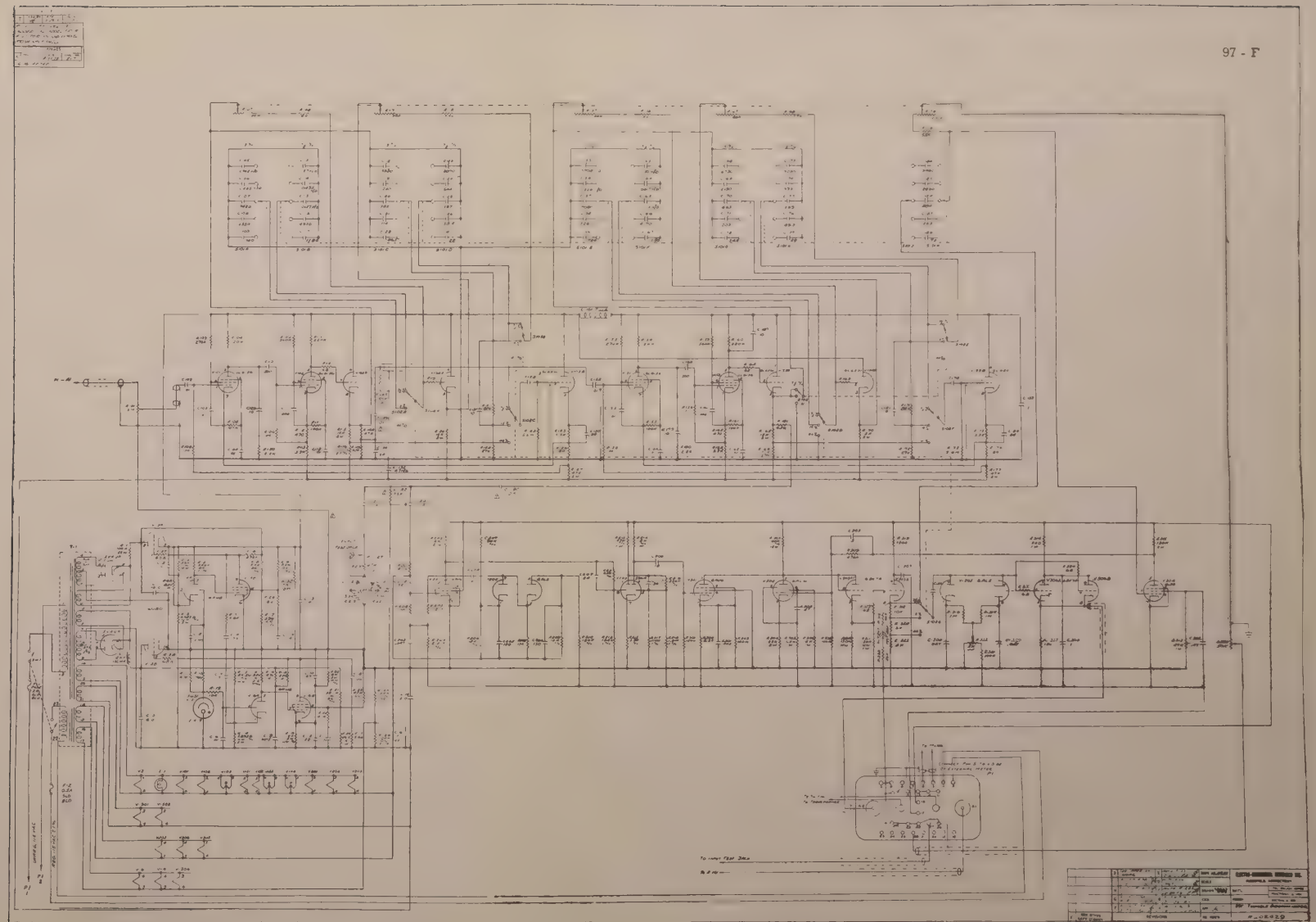


Fig. VII-8 F

TUNABLE DISCRIMINATOR—MODEL 97

REPLACEABLE PARTS

SYMBOL	DESCRIPTION	MANUFACTURER	TYPE & TOLERANCE
R-1	100 ohm	Dale	B-25 10%
R-2	330 K	Electra	DC-1/2C 1%
R-3	6485 ohm	Dale	RS-5 1%
R-4	25 K	Dale	RS-10 1%
R-4A	820 K	Allen Bradley	EB 10%
R-5	5.6 K	Allen Bradley	EB 10%
R-6	270 K	Allen Bradley	EB 10%
R-7	39 K	Electra	DC 1/2C 1%
R-8	150 K	I.R.C.	MDC 1%
R-9	82 K	I.R.C.	MDC 1%
R-10	1 megohm	Allen Bradley	EB 10%
R-11	47 K	Allen Bradley	EB 10%
R-13	8 K	Dale	RS-5 1%
R-14	5895 ohms	Dale	RS-5 1%
R-15	820 K	Electra	DC 1/2C 1%
R-16	470 K	Allen Bradley	EB 10%
R-17	5.6 K	Allen Bradley	EB 10%
R-18	220 K	Allen Bradley	EB 10%
R-19	10 K	Dale	RS-5 1%
R-20	8 K	Dale	RS-5 1%
R-21	38.1 K	Electra	DC-1 1%
R-22	4.1 K	Electra	DC 1/2C 5%
R-23	47 K	Electra	DC 1/2C 1%
R-24	26.5 K	Electra	DC-1 1%
R-25	120 K	Electra	DC 1/2C 1%
R-26	100 K	Electra	DC 1/2C 1%
R-27	68 ohm	Allen Bradley	EB 10%
R-28	68 ohm	Allen Bradley	EB 10%
R-29	18 K	Allen Bradley	EB 10%
R-32	5 K	Sage	10W 10%
R-101	.5 Meg	Allen Bradley	54274 Pot A-0.5 Meg. Type J
R-102	1 Meg	Allen Bradley	EB 10%
R-103	270 K	Electra	DC 1/2A 1%
R-104	120 K	Electra	DC 1/2A 1%
R-105	100 K	Allen Bradley	EB 10%
R-106	1 Meg	Allen Bradley	EB 10%
R-107	20 K	General Radio	Part of 5-gang pot EMR B-02377
R-108	8 K	Electra	DC 1/2A 1%
R-109	560 K	Electra	DC 1/2A 1%
R-110	220 K	Electra	DC 1/2A 1%
R-111	100 K	Allen Bradley	EB 10%
R-112	470 ohm	Electra	DC 1/2A 1%
R-113	3.3 K	Electra	DC 1/2A 1%

SYMBOL	DESCRIPTION	MANUFACTURER	TYPE & TOLERANCE
R-114	68 ohm	Allen Bradley	EB 10%
R-115	15 K	Electra	DC2 1%
R-116	330	Electra	DC 1/2A 1%
R-117	20 K	General Radio	Part of 5-gang pot EMR B-02377
R-118	7.7 K	Electra	DC 1/2A 1%
R-119	68 ohm	Allen Bradley	EB 10%
R-120	15 K	Allen Bradley	HB 10%
R-121	82 K	Electra	DC 1/2A 1%
R-122	27 K	Electra	DC 1/2A 1%
R-123	5.6 Meg	Allen Bradley	EB 10%
R-125	3.3 K	Electra	DC 1/2A 1%
R-126	180 ohm	Electra	DC 1/2A 1%
R-127	47 K	Electra	DC2 1%
R-128	47 K	Allen Bradley	EB 10%
R-129	4.7 K	Allen Bradley	EB 10%
R-130	2.2 K	Allen Bradley	EB 10%
R-152	1 Meg	Allen Bradley	EB 10%
R-153	270 K	Electra	DC 1/2A 1%
R-154	120 K	Electra	DC 1/2A 1%
R-155	100 K	Allen Bradley	EB 10%
R-156	1 Meg	Allen Bradley	EB 10%
R-157	20 K	General Radio	Part of 5-gang pot EMR B-02377
R-158	8 K	Electra	DC 1/2A 1%
R-159	560 K	Electra	DC 1/2A 1%
R-160	220 K	Electra	DC 1/2A 1%
R-161	100 K	Allen Bradley	EB 10%
R-162	470 ohm	Electra	DC 1/2A 1%
R-163	3.3 K	Electra	DC 1/2A 1%
R-164	68 ohm	Allen Bradley	EB 10%
R-165	15 K	Electra	DC2 1%
R-166	330	Electra	DC 1/2A 1%
R-167	20 K	General Radio	Part of 5-gang pot EMR B-02377
R-168	7.7 K	Electra	DC 1/2A 1%
R-169	68 ohm	Allen Bradley	EB 10%
R-170	15 K	Allen Bradley	HB 10%
R-171	82 K	Electra	DC 1/2A 1%
R-172	27 K	Electra	DC 1/2A 1%
R-173	5.6 Meg	Allen Bradley	EB 10%
R-175	3.3 K	Electra	DC 1/2A 1%
R-176	180 ohm	Electra	DC 1/2A 1%
R-177	47 K	Electra	DC2 1%
R-178	200 K	General Radio	Part of 5-gang pot EMR B-02377
R-179	55 K	Eastern Precision	NS6A LOC 1%
R-180	2.2 K	Allen Bradley	EB 10%
R-181	4.7 K	Allen Bradley	EB 10%

SYMBOL	DESCRIPTION	MANUFACTURER	TYPE & TOLERANCE
R-200	47 K	Electra	DC 1/2A 1%
R-201	47 K	Allen Bradley	EB 10%
R-202	1 Meg	Allen Bradley	EB 10%
R-203	1.2 Meg	Electra	DC 1/2A 1%
R-204	2.2 Meg	Electra	DC 1/2A 1%
R-205	12 K	Allen Bradley	HB 10%
R-206	18 K	Electra	DC 1/2A 1%
R-207	180 K	Electra	DC 1/2A 1%
R-208	1 Meg	Allen Bradley	EB 10%
R-209	18 K	Electra	DC 1/2A 1%
R-210	180 K	Electra	DC 1/2A 1%
R-211	65 K	Electra	DC 1/2A 1%
R-212	164 K	Electra	DC 1/2A 1%
R-213	47 K	Electra	DC1 1%
R-214	18 K	Electra	DC1 1%
R-215	3.9 K	Electra	DC 1/2A 1%
R-216	330 K	Electra	DC 1/2A 1%
R-217	100 K	Electra	DC 1/2A 1%
R-218	1.5 Meg	Electra	DC 1/2A 1%
R-219	3.3 K	Allen Bradley	EB 10%
R-220	3.3 K	Allen Bradley	EB 10%
R-301	120 K	Allen Bradley	EB 10%
R-302	8.2 K	Allen Bradley	EB 10%
R-303	120 K	Allen Bradley	EB 10%
R-304	22 K	Allen Bradley	HB 10%
R-305	1.2 K	Allen Bradley	GB 10%
R-306	18 K	Allen Bradley	GB 10%
R-307	40 K	Mepco	P-15 1%
R-308	100 K	Allen Bradley	EB 10%
R-309	470 K	Allen Bradley	EB 10%
R-310	Low C 150 K	Eastern Precision	NS6A CAP 1%
R-311	Low C 150 K	Eastern Precision	NS6A CAP 1%
R-312	10 K	Sage	SS5W 1%
R-313	47 K	Allen Bradley	GB 10%
R-314	560 ohm	Allen Bradley	GB 10%
R-315	120 K	Allen Bradley	HB 10%
R-316	1 Meg	Allen Bradley	EB 10%
R-317	1 Meg	Allen Bradley	EB 10%
R-319	1.2 K	Allen Bradley	EB 10%
R-320	50 K	Helipot	50 K Ten at ±0.5% (Series A) Turn Pot
R-321	100 K	Allen Bradley	EB 10%
R-322	5 K	Clarostat	47M9 5000 Pot.
R-323	4 K	Sage	S2W 1%
R-324	68 ohm	Allen Bradley	EB 10%
R-325	15 K	Mepco	P-15 3%
R-327	68 ohm	Allen Bradley	EB 10%
R-328	6 K	Sage	SS5W 1%
R-329	560 ohm	Allen Bradley	EB 10%
R-330	68 ohm	Allen Bradley	EB 10%

SYMBOL	DESCRIPTION		MANUFACTURER	TYPE & TOLERANCE
C-1	10 mfd	600 VDC	Sprague	CP70B1 F F106V
C-2	.0005 mfd	300 VDC	El Menco	CM-15-501
C-3	1. mfd	400 VDC	Pyramid	7PGIHL 4-1
C-4	.001 mfd	500 VDC	El Menco	CM-19-102 10%
C-5	6 mfd	600 VDC	Sprague	CP70B1 F F605V
C-6	.01 mfd	500 VDC	El Menco	CM35-B 103 10%
C-7	.5 mfd	400 VDC	Sprague	CP54-B1 EE-504M
C-8	.001 mfd	500 VDC	El Menco	CM-19-102 10%
C-9	.01 mfd	500 VDC	El Menco	CM35-B 103 10%
C-10	.47 mfd	300 VDC	Pyramid	7PGH3-P47
C-11	.22 mfd	200 VDC	Pyramid	PGH2 P22
C-12	.22 mfd	200 VDC	Pyramid	PGIH2-P22
C-13	1. mfd	400 VDC	Tobe	OMB-401 20%
C-14	2. mfd	400 VDC	Tobe	OMB-402 20%
C-15	Power Transformer with capacitor (Used on A or D Models Only)		Raytheon	W-6854-B
C-16	.01 mfd	500 VDC	El Menco	CM35-B 103
C-17	.039 mfd	200 VDC	Pyramid	PGH2
C-102	.01 mfd	600 VDC	Pyramid	EPGIX 20%
C-103	.01 mfd	600 VDC	Pyramid	PGIM 20%
C-104	.01 mfd	500 VDC	El Menco	CM35B-103K 10%
C-105	.0742 mfd	400 VDC	Efcon	MHA 1%
C-106	.0235 mfd	400 VDC	Efcon	MHA 1%
C-107	7420 mmfd	300 VDC	El Menco	CM-35 1%
C-108	2350 mmfd	500 VDC	El Menco	CM-30 1%
C-109	780 mmfd	500 VDC	El Menco	CM-19 1%
C-110	500 mmfd	500 VDC	El Menco	CM15E-300J 5%
C-111	.005 mfd	600 VDC	Pyramid	PGIM 20%
C-112	.01 mfd	500 VDC	El Menco	CM35B-103K 10%
C-113	.157 mfd	400 VDC	Efcon	MHA 1%
C-114	.0495 mfd	400 VDC	Efcon	MHA 1%
C-115	.0157 mfd	400 VDC	Efcon	MHA 1%
C-116	4950 mmfd	500 VDC	El Menco	CM-30 1%
C-117	1180 mmfd	500 VDC	El Menco	CM-19 1%
C-118	3920 mmfd	500 VDC	El Menco	CM-30 1%
C-119	1240 mmfd	500 VDC	El Menco	CM-19 1%
C-120	382 mmfd	500 VDC	El Menco	CM-15 1%
C-121	114 mmfd	500 VDC	El Menco	CM-15 1%
C-122	26.5 mmfd	500 VDC	El Menco	CM-15 1%
C-123	2070 mmfd	500 VDC	El Menco	CM-30 1%
C-124	644 mmfd	500 VDC	El Menco	CM-19 1%
C-125	197 mmfd	500 VDC	El Menco	CM-15 1%
C-126	58.4 mmfd	500 VDC	El Menco	CM-15 1%
C-127	22 mmfd	500 VDC	El Menco	CM-15 1%

SYMBOL	DESCRIPTION		MANUFACTURER	TYPE & TOLERANCE	
C-128	.1 mfd	300 VDC	Pyramid	EPGIX	20%
C-129	10 mmfd	500 VDC	El Menco	CM15C-100J	5%
C-130	24 mmfd	500 VDC	El Menco	CM15E-240J	5%
C-131	10 mmfd	500 VDC	El Menco	CM15C-100J	5%
C-132	.47 mfd	300 VDC	Pyramid	7PGH	20%
C-133	.1 mfd	300 VDC	Pyramid	7EPGIH	20%
C-134	24 mmfd	500 VDC	El Menco	CM15E-240J	5%
C-152	.01 mfd	600 VDC	Pyramid	EPGIX	20%
C-153	.01 mfd	600 VDC	Pyramid	PGIM	20%
C-154	.01 mfd	600 VDC	Pyramid	EPGIX	20%
C-155	.0708 mfd	400 VDC	Efcon	MHA	1%
C-156	.0226 mfd	400 VDC	Efcon	MHA	1%
C-157	7080 mmfd	300 VDC	El Menco	CM-35	1%
C-158	2260 mmfd	500 VDC	El Menco	CM-30	1%
C-159	724 mmfd	500 VDC	El Menco	CM-19	1%
C-160	500 mmfd	500 VDC	El Menco	CM15E-501J	5%
C-161	.005 mfd	600 VDC	Pyramid	PGIM	20%
C-162	.01 mfd	600 VDC	Pyramid	EPGIX	20%
C-163	.130 mfd	400 VDC	Efcon	MHA	1%
C-164	.0417 mfd	400 VDC	Efcon	MHA	1%
C-165	.013 mfd	400 VDC	Efcon	MHA	1%
C-166	4170 mmfd	500 VDC	El Menco	CM-30	1%
C-167	1150 mmfd	500 VDC	El Menco	CM-19	1%
C-168	6730 mmfd	300 VDC	El Menco	CM-35	1%
C-169	2150 mmfd	500 VDC	El Menco	CM-30	1%
C-170	663 mmfd	500 VDC	El Menco	CM-19	1%
C-171	205 mmfd	500 VDC	El Menco	CM-15	1%
C-172	54.9 mmfd	500 VDC	El Menco	CM-15	1%
C-173	3090 mmfd	500 VDC	El Menco	CM-30	1%
C-174	993 mmfd	500 VDC	El Menco	CM-19	1%
C-175	299 mmfd	500 VDC	El Menco	CM-15	1%
C-176	89.3 mmfd	500 VDC	El Menco	CM-15	1%
C-177	29 mmfd	500 VDC	El Menco	CM-15	1%
C-178	.1 mfd	300 VDC	Pyramid	EPGIX	20%
C-179	10 mmfd	500 VDC	El Menco	CM15C-100J	5%
C-180	24 mmfd	500 VDC	El Menco	CM15E-240J	5%
C-181	10 mmfd	500 VDC	El Menco	CM15C-100J	5%
C-182	9460 mmf	500 VDC	Cornell-Dubilier	1A (Neg. Temp.)	1%
C-183	2890 mmf	500 VDC	Cornell-Dubilier	5A coef. -40	1%
C-184	884 mmf	500 VDC	Cornell-Dubilier	5A to 0 ppm/	1%
C-185	265 mmf	500 VDC	Cornell-Dubilier	5A Deg. C)	1%
C-186	72 mmf	500 VDC	Cornell-Dubilier	5A	1%
C-187	10 mmfd	500 VDC	El Menco	CM15C-100J	5%
C-188	100 mmf	500 VDC	El Menco	CM15E-101J	5%
C-201	.22 mfd	300 VDC	Pyramid	7EPGIH 3-P22	20%
C-202	.05 mfd	200 VDC	Pyramid	EPGIH	20%
C-203	.047 mfd	200 VDC	Pyramid	EPGH	20%

SYMBOL	DESCRIPTION		MANUFACTURER	TYPE & TOLERANCE	
C-204	.1 mfd	300 VDC	Pyramid	EPGIH	20%
C-205	150 mmfd	500 VDC	El Menco	CM15E-151J	5%
C-206	150 mmfd	500 VDC	El Menco	CM15E-151J	5%
C-207	24 mmfd	500 VDC	El Menco	CM15E-240J	5%
C-208	30 mmfd	500 VDC	El Menco	CM15E-300J	5%
C-209	10 mmfd	500 VDC	El Menco	CM15C-100J	5%
C-210	.047 mfd	300 VDC	Pyramid	EPGIX	20%
C-301	.002 mfd	500 VDC	El Menco	CM20B-202K	10%
C-302	.47 mfd	300 VDC	Pyramid	7PGIH	20%
C-303	3 mmfd	300 VDC	El Menco	CM15E 030M	5%
C-304	.1 mfd	600 VDC	Pyramid	7PGIM	20%
C-305	.47 mfd	200 VDC	Pyramid	7PGIH	20%
C-306	.1 mfd	300 VDC	Pyramid	EPGIH	20%
C-307	.1 mfd	600 VDC	Pyramid	7PGIM	20%
C-308	.047 mfd	200 VDC	Pyramid	EPGH	20%
C-309	.047 mfd	200 VDC	Pyramid	EPGH	20%
V-1			Sylvania	5V4GA Tube	
V-2			Sylvania	5V4GA Tube	
V-3			R.C.A.	6080 Tube	
V-4			Tung-Sol	6AW8 Tube	
V-5			Raytheon	5651-W A Tube	
V-6			Tung-Sol	6AW8 Tube	
V-101	GL6136		G.E.		
V-102	GL6136		G.E.		
V-103	GL6201		G.E.		
V-104	GL6201		G.E.		
V-151	GL6136		G.E.		
V-152	GL6136		G.E.		
V-153	GL6201		G.E.		
V-201	6AU6		R.C.A.		
V-202	6AL5		R.C.A.		
V-203	5964		R.C.A.		
V-301	6AU6		R.C.A.		
V-302	6AU6		R.C.A.		
V-303	6BK7A		G.E.		
V-304	GL6136		G.E.		
V-305	6AL5		R.C.A.		
V-306	6BK7A		G.E.		
D-101	IN38A or IN58A		Sylvania		
D-102	IN38A or IN58A		Sylvania		
L-1	Filter Reactor		Colin Campbell	L-1855	
L-101	7 μh RF Choke		Ohmite	Z-50	
M-101	200 μa Meter		Marion	0-10HS2 Special	
P-1	Connector		Cannon	DPD-D 32C2-33S-1L	
S-101	Range Switch		Centralab	Special EMR B-02457	
S-102	Bandwidth Switch		Centralab	Special EMR B-02458	

SYMBOL	DESCRIPTION	MANUFACTURER	TYPE & TOLERANCE
SW-1	Power Switch	A.H. & H.	81024-F
T-1	Power Transformer with capacitor (Used on A or D Models only)	Raytheon	W-6854-8 EMR B-00042
T-1	Power Transformer (Used on F Models only)	Colin Campbell	L-1926
F-1	Fuse	Littelfuse	313002 2 amp.
F-2	Fuse (Used on F Models Only)	Littelfuse	313.500 .5 amp.
	Rack Connector (Mates with P1)	Cannon	DPD-D 32C2-34P-1L
	Pin Jack	E.F. Johnson	105-602-1 Red
	Pin Jack	E.F. Johnson	105-610-1 Dk. Blue
I-1	Pilot Light	Dialco	8-1930-121 With No. 328 Lamp

INSTRUCTION MANUAL

VARIABLE LOW PASS OUTPUT FILTER

MODEL 95A

STARTING WITH SERIAL No. 11

ELECTRO-MECHANICAL RESEARCH, INC.

SARASOTA, FLORIDA

SECTION I
TABLE OF CONTENTS

Section	Page
Section I - Table of Contents	I-1
Section II - Photograph of Equipment	II-1
Section III - Description and Installation	
1. General	III-1
2. Characteristics	III-1
3. Installation	III-1
Section IV - Operating Procedure	
1. Input, Output and Power Connections	IV-1
2. Front Panel Controls	IV-1
a. Cut-Off Frequency Switch and Dial	IV-1
b. Frequency Characteristic	IV-1
c. Output Volts at Band Edge	IV-1
d. Output Meter	IV-1
e. Increase Sensitivity	IV-1
f. Amplifier Zero Balance	IV-1
g. Input and Output Jacks	IV-2
3. External Gain Control	IV-2
4. External Zero Offset	IV-2
Section V - Theory of Operation	V-1
Section VI - Maintenance	
1. Inspection	VI-1
2. Voltage Measurements	VI-1
3. Performance Checks	VI-1
Section VII - Tables and Drawings	VII-1
1. Attenuation Characteristics - Model 95A	Fig. VII-2
2. Location of Components - Top View	Fig. VII-3
3. Location of Components - Bottom View	Fig. VII-4
4. Tube Socket Voltages	Fig. VII-5
5. Model 95 Circuit Diagrams	Fig. VII-6 A D F
6. Model 95 Parts List	Fig. VII-7 VII-11

Model 95 Equipment

SECTION III
DESCRIPTION AND INSTALLATION

1. GENERAL

The EMR VARIABLE LOW-PASS OUTPUT FILTER, MODEL 95, combines a power amplifier flat to DC with a low-pass electronic filter network of continuously variable cut-off frequency. Although specifically designed for use with the EMR TUNABLE DISCRIMINATOR, MODEL 97, in F-M telemetering applications, it finds use wherever a flexible filter is required, and in particular when high output capability is needed.

The MODEL 95 provides a cut-off frequency which may be adjusted for any point between 3 cps and 10.5 Kc. Attenuation beyond cut-off is at the rate of 36 db per octave. Two attenuation characteristics are provided in the pass band. The first is flat within ±0.5 from DC to the cut-off frequency. The second provides a gradual or Gaussian roll-off which is down 3 db at the cut-off frequency, and which has a linear phase characteristic.

A power amplifier at the output of the filter delivers up to ±90 volts peak at a maximum current capability of ±25 ma. peak. The maximum gain through the unit is 15. A continuous reduction of gain to 0.8 is possible.

A zero-center meter on the front panel of the Model 95 provides a continuous indication of the DC level at the input; and reads full scale for ±6 volts.

2. CHARACTERISTICS

The LOW-PASS OUTPUT FILTER, MODEL 95 is designed to the following specifications:

FREQUENCY RANGE:
Pass band from DC to any cut-off frequency from 3 cps to 10.5 Kc.

ATTENUATION CHARACTERISTICS:
In the pass band, flat response ±0.5 db or Gaussian roll-off down 3 db at cut-off frequency. Above cut-off, attenuates at the rate of 36 db per octave.

INPUT IMPEDANCE:
Minimum of 40K ohms. Input is applied directly to an electronic filter network. (Maximum source impedance 1000 ohms).

OUTPUT:
Output is single ended and referred to ground. Maximum output capability is ±90 volts peak, with a maximum current of ±25 ma. peak. Output impedance is less than 10 ohms. An output attenuator provides continuous gain adjustment over a range greater than 15:1.

OUTPUT NOISE:
In the wide-band, full gain position, output noise is 60 mv. RMS. It is proportional to gain.

OUTPUT LINEARITY:
Less than 1% total non-linearity within rated operation.

OUTPUT STABILITY:
In the full gain position, drift is less than 500 mv. in a 15 hour period after a 15 minute warmup. Variation due to power source voltage is less than 25 mv. for a change from 105 to 125 volts.

AUTOMATIC CALIBRATION:
Provision is made for introduction of an external zero offset voltage, and for external gain control.

POWER REQUIRED:
105 - 125 volts, 60 cps, 190 watts.

PANEL SIZE:
5-1/4'' x 19''

CHASSIS SIZE:
16-3/8'' wide by 16-1/8'' deep.

DEPTH BEHIND PANEL:
16-3/8'' maximum

WEIGHT:
47 lbs.

PANEL FINISH:
EMR light umber gray.

3. INSTALLATION

The VARIABLE LOW-PASS OUTPUT FILTER, MODEL 95, has been designed for standard rack mounting with or without slides. If pullout, non-turnover slides are required, brackets have been included on the discriminator sides for the

addition of Grant Pulley and Hardware Co. slides. To slide mount the discriminator, the slides previously assembled in the rack should be fully withdrawn from the rack and the discriminator placed on the slides so that the discriminator brackets support the discriminator on the slides. The bracket should be secured to the slides with the screws provided. To slide the discriminator into the rack, release the stops by depressing the levers on the top of each slide.

When slides are not used, the discriminator may be mounted in the rack by providing brackets in the rack for supporting the discriminator on the brackets included on the sides of the unit.

In either case, the discriminator is held in the rack by means of lock fasteners on each side of the front panel.

The open center section of the discriminator chassis, into which all tubes and other heat producing components project, permits efficient cooling of the discriminator. The airstream of a rack ventilator may be directed through the duct formed by the center section of several discriminators mounted in a rack.

SECTION IV
OPERATING PROCEDURE

1. INPUT, OUTPUT, AND POWER CONNECTIONS

Connections to the MODEL 95 are made to a Cannon Receptacle located at the rear of the unit. Cannon Plug No. DPD-D32C2-33S-1L inserts in this receptacle. Pin connections are shown by the circuit diagram, Fig. VII-6. For special connections see Paragraphs 3 and 4, Sect. IV.

NOTE: Pin 16 is connected to the +200 VDC regulated supply. Pin 17 is connected to the -200 VDC regulated supply. When the MODEL 95 is connected to an EMR TUNABLE DISCRIMINATOR, MODEL 97, these terminals supply B power to the latter equipment. When the MODEL 95 is operated alone as a filter, equivalent loads must be added as follows:

Pin 16 (B+) to ground	4000 ohms,	20 watts
Pin 17 (B-) to ground	6000 ohms,	10 watts

2. FRONT PANEL CONTROLS

The location of the front panel controls is shown by Fig. II-1. Their function is as follows:

a. CUT-OFF FREQUENCY SWITCH AND DIAL

Choice of cut-off frequency is made by the FREQUENCY RANGE knob and the associated CUT-OFF FREQUENCY DIAL located at the right of the front panel. Markings for the FREQUENCY RANGE knob indicate which scale of the dial shall be read as well as the proper multiplier. For example, 3 x 10 indicates the scale which is graduated from 3 to 10, with a lowest available cutoff frequency of 30 cps. The unit shown by the photograph of Fig. II-1 is set for a cut-off frequency of 145 cps.

b. FREQUENCY CHARACTERISTIC

This knob provides a choice of either the Standard or Gaussian filter characteristics described in Section III or shown by Fig. VII-1.

c. OUTPUT VOLTS AT BAND EDGE

This dual control located at the lower left corner of the front panel provides continuous adjustment of output level by means of an outer vernier potentiometer knob and a concentric inner switch knob. The switch markings give the range of the peak output voltage corresponding to an input of ±6 volts peak. Ranges are 5-10, 10-20, 20-40, and 40-90 volts. The vernier potentiometer covers each range with some overlap.

In the switch position marked "EXT", provision is made for an external gain control. For details see Paragraph 3.

d. OUTPUT METER

The OUTPUT meter measures the DC signal level in the filter. It is located in the feedback circuit of the output amplifier in such a way that its indication is independent of the gain control setting. It reads ±100 for ±6 volts DC at the input to the filter.

e. INCREASE SENSITIVITY

This pushbutton located below the OUTPUT meter increases the sensitivity of the meter circuit approximately eight times. It is useful in achieving a zero balance of the output amplifier using the AMPLIFIER ZERO BALANCE ADJUSTMENT.

f. AMPLIFIER ZERO BALANCE

A zero-balance of the output amplifier should be made when the MODEL 95 is placed in operation. The AMPLIFIER ZERO BALANCE control is a through-panel screwdriver adjustment located at the center of the front panel. Pushing the slotted shaft inward to engage the balance potentiometer simultaneously switches the output amplifier to ground. In this way only the balance of the output stage is adjusted, a necessary arrangement if the zero point of the filter is to remain independent of the output gain control.

Because of the switching arrangement, the zero balance adjustment may be carried out without disconnecting any signal applied at the input to the MODEL 95. The INCREASE SENSITIVITY button should be used for accurate results when the OUTPUT meter is used as a balance indicator.

The first amplifier section of the MODEL 95 has been designed to balance approximately at zero, and for many applications no further adjustment is required. In the event that a finer balance is necessary, this can be applied externally as described in Paragraph 4.

g. INPUT AND OUTPUT JACKS

The INPUT test jack connects with Pin A1 of the rear receptacle; the OUTPUT jack with Pin B. For a ground connection use any convenient chassis location.

3. EXTERNAL GAIN CONTROL

When the OUTPUT VOLTS switch is in the position marked "EXT", a voltage divider external to the equipment may be substituted for the corresponding internal networks. The external divider is placed across the low impedance output point (Pin 8) and ground, while the tap is connected to Pin 10. Low capacity shielded leads must be used with this divider, and the total capacity to ground must be less than 700 mmf. Values for the divider should be similar to those shown on the gain control switch in the circuit schematic, Fig. VII-6 . The capacity across the upper resistor must be included.

4. EXTERNAL ZERO OFFSET

Application of a DC voltage at Pin 19 of the rear receptacle provides for zero balance or zero offset at the first filter amplifier.

SECTION V
THEORY OF OPERATION

The VARIABLE LOW-PASS OUTPUT FILTER, MODEL 95, consists of two electronic filter amplifiers together with a regulated power supply. Each filter amplifier is composed of a high-gain DC amplifier in a feedback arrangement with tuned R-C networks. The amplifiers operate similarly, however, the second includes a power output stage and a gain control.

The R-C networks of the filter amplifiers consist of four identical ganged variable resistors which vary from a minimum of 40K ohms to a maximum of 140K ohms as the CUT-OFF FREQUENCY dial is adjusted. Three precision capacitors are required with these resistors for each of the seven frequency ranges covered by the MODEL 95. Additional capacitors are required for the Gaussian adjustment.

Input signals to the MODEL 95 are passed through the R-C networks to the DC amplifier. The amplifier output is fed back to another point on the same network, in such a way that the overall gain is reduced to unity in the case of the first amplifier, or an adjustable level for the output amplifier. Gain adjustment of the output amplifier is achieved by variation of the feedback ratio.

The combination of R-C networks and DC amplifiers produces the filter characteristics described in Section III. Each amplifier provides an attenuation rate above cut-off of 18 db per octave. For the Standard characteristic the shape of response of the two amplifiers is identical. For the Gaussian characteristic the response of the first section is altered to provide 3 db of attenuation at the cut-off frequency.

SECTION VI
MAINTENANCE

1. INSPECTION

The EMR Variable Low-Pass Output Filter, Model 95, should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. A visual inspection should be made each week, checking for loose components and evidence of overheating, and a complete inspection every six months should include the following:

a. Test all vacuum tubes.

b. Tighten all screws.

c. Inspect wiring for loose connections and evidence of overheating.

d. Check all tube socket voltages.

e. Check performance.

f. Replace defective components.

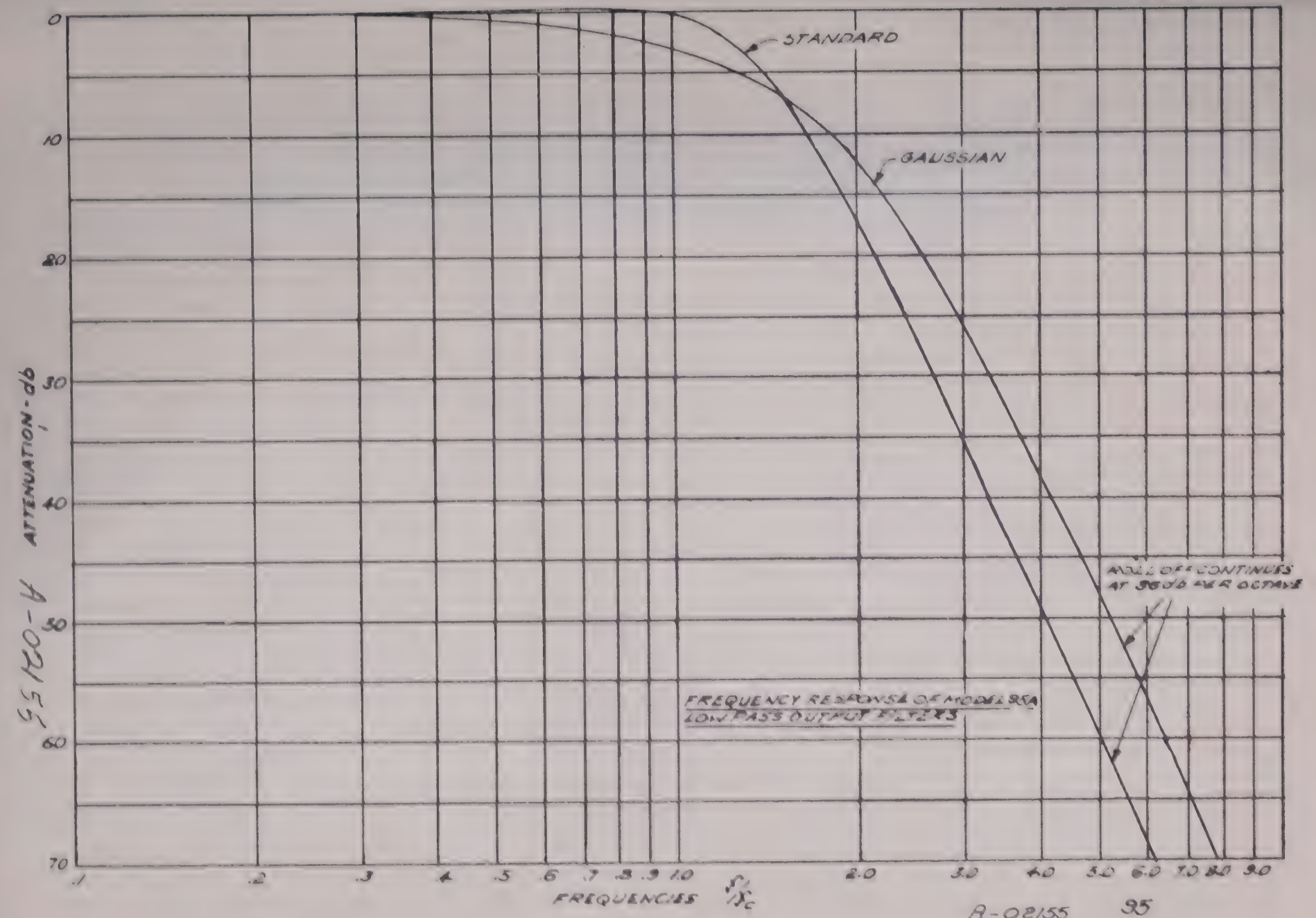
2. VOLTAGE MEASUREMENTS

All DC and AC voltage measurements may be made using the chassis ground as a reference. Tube socket voltages are given in Section VII, Fig. 5.

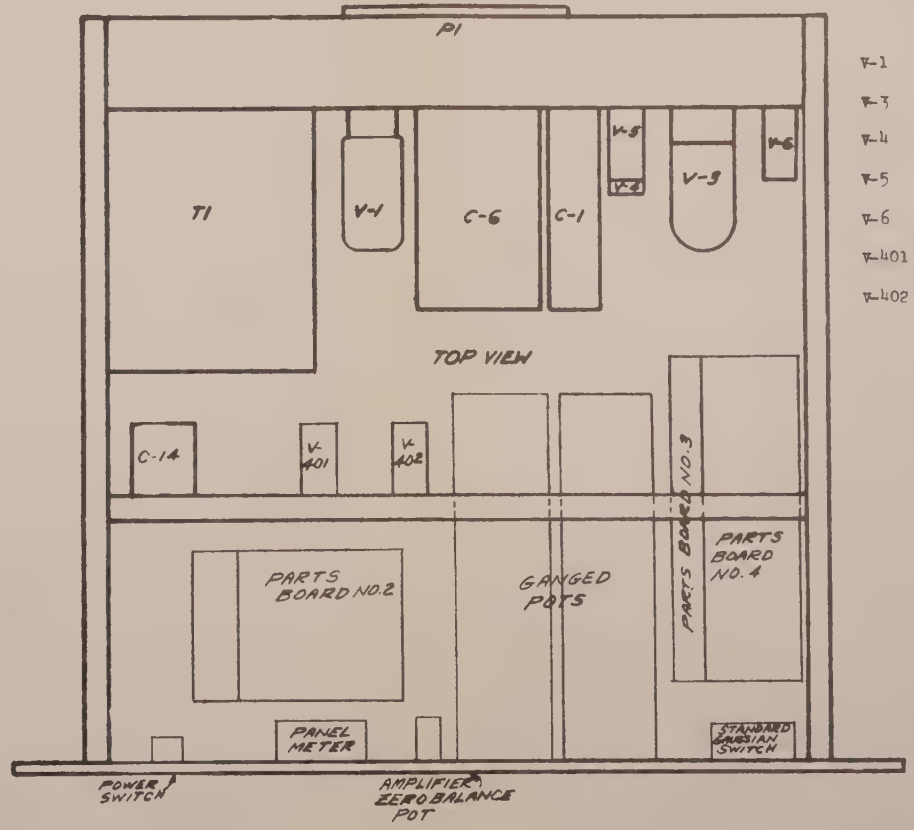
3. PERFORMANCE CHECKS

Performance checks on the Model 95 include standard procedures for the checkout of DC amplifiers with feedback, of electronic filter networks, and of regulated power supplies. Reference to the Model 95 schematic, Fig. VII-6, will provide detailed circuit information.

SECTION VII
TABLES AND DRAWINGS


STANDARD
GAUSSIAN
ROLL OFF CONTINUES AT 30DB PER OCTAVE
FREQUENCY RESPONSE OF MODEL 95A LOW PASS OUTPUT FILTERS
ATTENUATION - db
FREQUENCIES f/fc
0
10
20
30
40
50
60
70
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0

A-02155

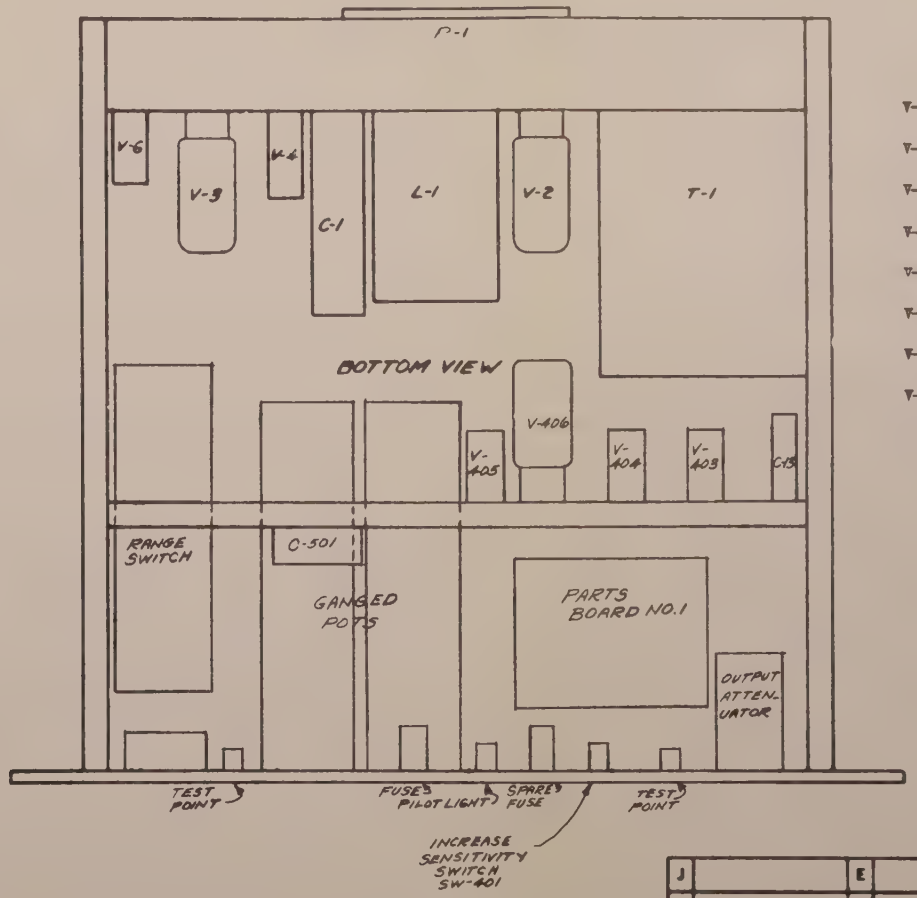


V-1	– 5V4GA.
V-3	– 6080
V-4	– 6AW8
V-5	– 5651
V-6	– 6AW8
V-401	– 12AY7
V-402	– 6U8

DO NOT SCALE DRAWING

J		E		DATE 1-25-55	ELECTRO-MECHANICAL RESEARCH INC. RIDGEFIELD, CONNECTICUT
I		D		SCALE ~	
H		C		DRAWN A.P.	MAT'L. ~ TOL. UNLESS NOTED
G		B		CKD. RCA	FINISH ~ FRACTIONAL ± 1/64 DECIMAL ± .005
F		A		APP'D.	LOCATION OF COMPONENTS
REVISIONS				NO. REQ'D. ~	35 B-02162

Fig. VII-3



V-2	– 5Y46A
V-3	– 6080
V-4	– 6AW8
V-6	– 6AW8
V-403	– 12AY7
V-404	– 6AU6
V-405	– 6197
V-406	– 6L6GB

DO NOT SCALE DRAWING

J		E		DATE 1-25-58	ELECTRO-MECHANICAL RESEARCH INC. RIDGEFIELD, CONNECTICUT
I		D		SCALE ~	
H		C		DRAWN HB	MAT'L ~ TOL. UNLESS NOTED
G		B		CK'D.	FINISH ~ FRACTIONAL ± 1/64 DECIMAL ± .010
F		A		APP. G.T.	LOCATION OF COMPONENTS
REVISIONS				NO. REQ'D. ~	95 B-02163

Fig. VII-4

TUBE SOCKET VOLTAGES

TYPICAL DC VOLTAGES

MODEL 95

Pin Numbers

Tube	1	2	3	4	5	6	7	8	9
V1	0	+350	0		0		0	+350	
V2	0	+117	0		0		0	+115	
V3	+150	+350	+200	-22	+90	0			
V4	-110	-111	-4			0	-4	+110	+142
V5	-111	-200		-200	-111		-200		
V6	-110	-111	-88			-85	-88	-60	-22
V401	+62	- .4	+1			+98	-1.6	0	
V402	+198	-2.4	+90			+115	0	- .04	-4.3
V403	+148	-3.3	0			+98	- .03	+2.	
V404	-200	-195			-12	-26	-195		
V405	-195	-195	0			- .18	-195	0	-195
V406			+198	+198	-12			- .18	

AC Volts

V-1		310		310	
V-2		375		375	

Fig. VII-5

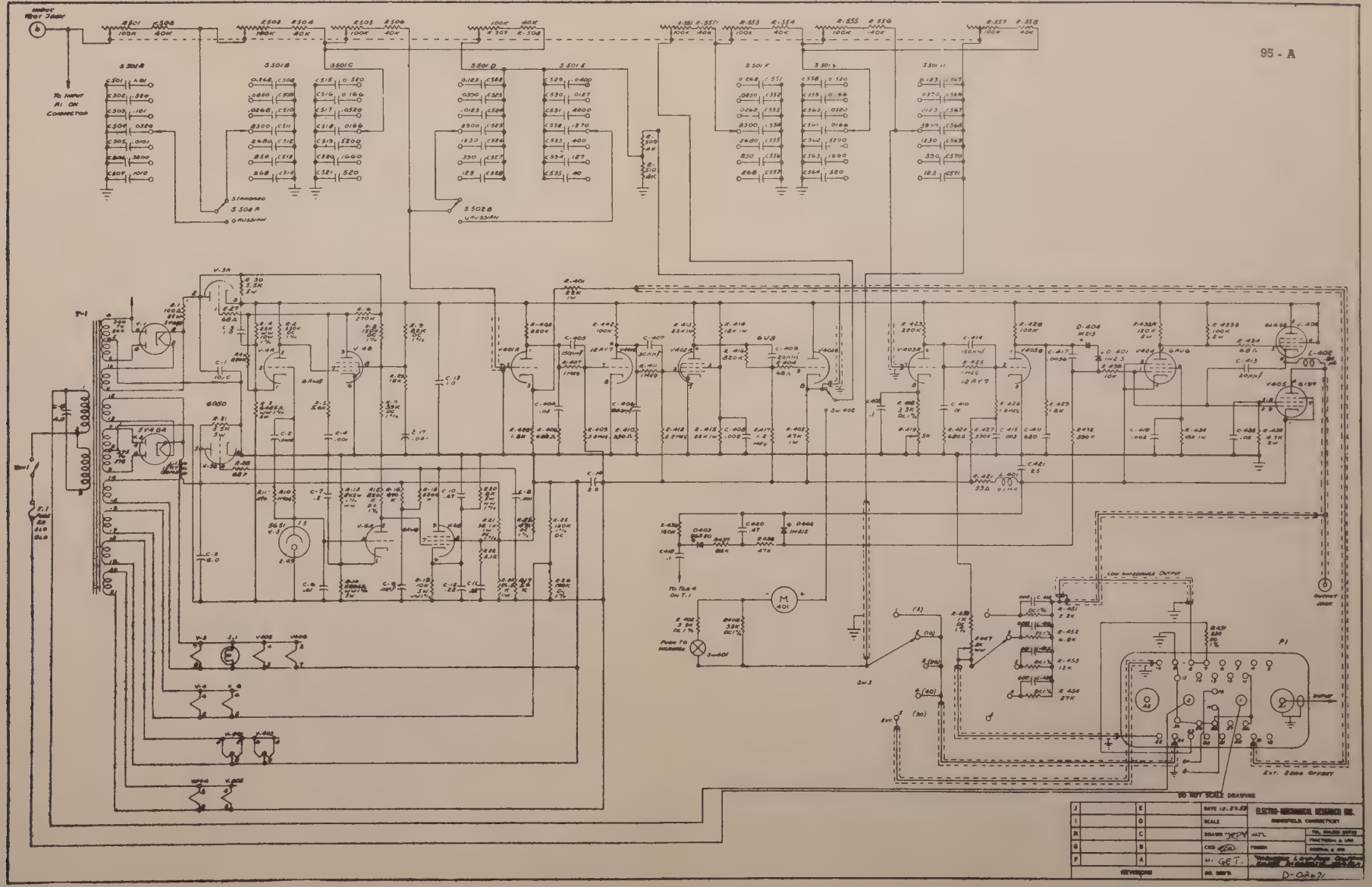

95 - A
DO NOT SCALE DRAWING
ELECTRO-MECHANICAL RESEARCH INC.
D-08071

Fig. VII-6 A

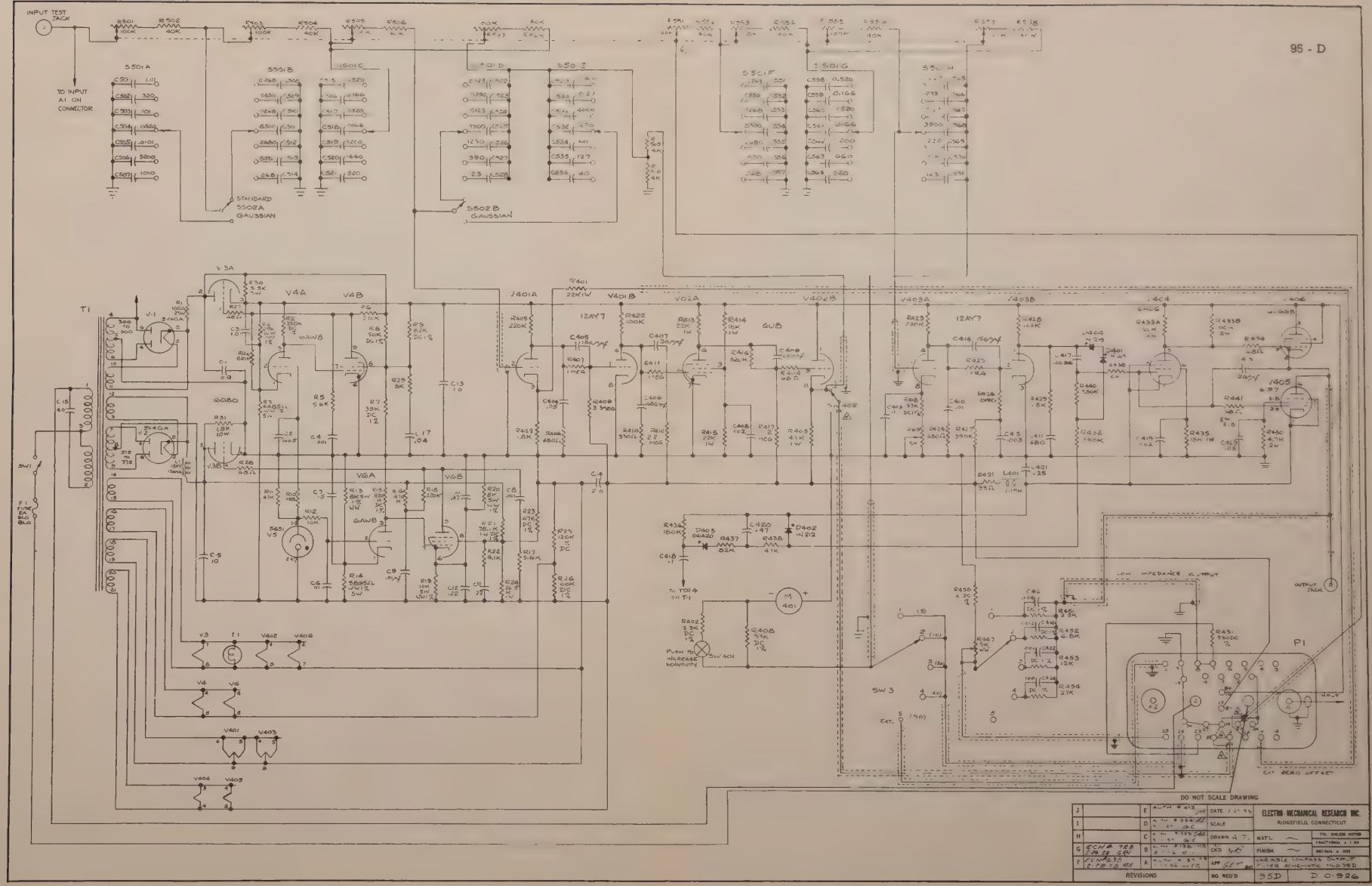
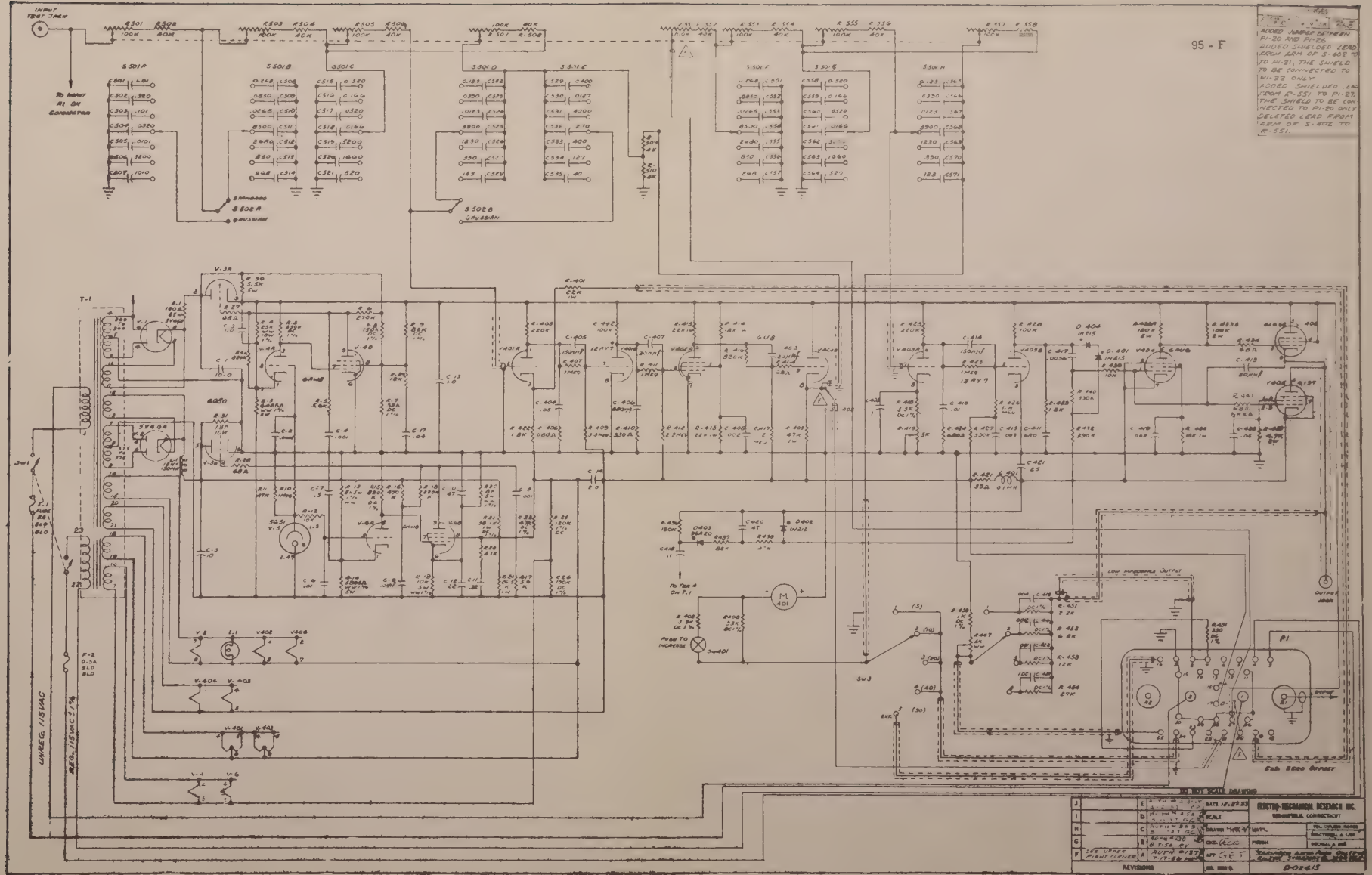

95 - D
INPUT TEST JACK
TO INPUT A1 ON CONNECTOR
STANDARD 5502A GAUSSIAN
5502B GAUSSIAN
T1
V1
V2
V3A
V3B
V4A
V4B
V5
VGA
VGB
12AY7
6U8
6AW8
6080
5642
5651
V401A
V401B
V402A
V402B
V403A
V403B
V404
V405
SW1
SW3
SW 401
M 401
D401 IN 23
D402 IN 212
D403 SD420
P1
INPUT
OUTPUT JACK
LOW IMPEDANCE OUTPUT
EXT.
CAT HEAD OFFSET
DO NOT SCALE DRAWING
ELECTRO-MECHANICAL RESEARCH INC.
RIDGEFIELD, CONNECTICUT
REVISIONS
NO. REQ'D
95D
D 01926

Fig. VII-6 D


95 - F
INPUT TEST JACK
To Input At ON Connector
S 501 A
S 501 B
S 501 C
S 501 D
S 501 E
S 501 F
S 501 G
S 501 H
Standard S 502 A
Gaussian S 502 B
V-1A
V-1B
V-2A
V-2B
V-3A
V-3B
V-4A
V-4B
V-5A
V-5B
V-6A
V-6B
T-1
6AU8
6DS8
5V4GA
5651
V-401A
V-401B
V-402A
V-402B
V-403A
V-403B
V-404A
V-404B
V-405A
V-405B
V-406A
V-406B
GUB
12AY7
12BY7
1N218
1N2IE
M 401
Push To Increase
To Term 4 On T-1
LOW IMPEDANCE OUTPUT
OUTPUT JACK
P1
J1
J2
J3
J4
J5
J6
J7
J8
J9
J10
J11
J12
J13
J14
J15
J16
J17
J18
J19
J20
J21
J22
J23
J24
J25
J26
J27
J28
J29
J30
J31
J32
J33
J34
J35
J36
J37
J38
J39
J40

VARIABLE LOW-PASS OUTPUT FILTER — MODEL 95

REPLACEABLE PARTS

SYMBOL	DESCRIPTION	MANUFACTURER	TYPE & TOLERANCE
R-1	100 ohm	Dale	B-25 10%
R-2	330 K	Electra	DC 1/2C 1%
R-3	6485 ohm	Dale	RS-5 1%
R-4	25 K	Dale	RS-10 1%
R-4A	820 K	Allen Bradley	EB 10%
R-5	5.6 K	Allen Bradley	EB 10%
R-6	270 K	Allen Bradley	EB 10%
R-7	39 K	Electra	DC 1/2C 1%
R-8	150 K	I.R.C.	MDC 1%
R-9	82 K	I.R.C.	MDC 1%
R-10	1 megohm	Allen Bradley	EB 10%
R-11	47 K	Allen Bradley	EB 10%
R-13	8 K	Dale	RS-5 1%
R-14	5895 ohms	Dale	RS-5 1%
R-15	820 K	Electra	DC 1/2C 1%
R-16	470 K	Allen Bradley	EB 10%
R-17	5.6 K	Allen Bradley	EB 10%
R-18	220 K	Allen Bradley	EB 10%
R-19	10 K	Dale	RS-5 1%
R-20	8 K	Dale	RS-5 1%
R-21	38.1 K	Electra	DC-1 1%
R-22	4.1 K	Electra	DC 1/2C 5%
R-23	47 K	Electra	DC 1/2C 1%
R-24	26.5 K	Electra	DC-1 1%
R-25	120 K	Electra	DC 1/2C 1%
R-26	100 K	Electra	DC 1/2C 1%
R-27	68 ohm	Allen Bradley	EB 10%
R-28	68 ohm	Allen Bradley	EB 10%
R-29	18 K	Allen Bradley	EB 10%
R-30	5.5 K	Sage	S5W 3%
R-31	1.8 K	Milwaukee	10W 10%
R-401	22 K	Allen Bradley	GB 10%
R-402	3.3 K	Electra	DC 1/2A 1%
R-403	47 K	Allen Bradley	GB 10%
R-404	68 ohm	Allen Bradley	EB 10%
R-405	220 K	Allen Bradley	EB 10%
R-406	680 ohm	Allen Bradley	EB 10%
R-407	1 Meg	Allen Bradley	EB 10%
R-408	33 K	Electra	DC 1/2A 1%
R-409	3.3 Meg	Allen Bradley	EB 10%
R-410	330 ohm	Allen Bradley	EB 10%
R-411	1 Meg	Allen Bradley	EB 10%
R-412	2.2 Meg	Allen Bradley	EB 10%
R-413	22 K	Allen Bradley	GB 10%
R-414	18 K	Allen Bradley	GB 10%
R-415	22 K	Allen Bradley	GB 10%

SYMBOL	DESCRIPTION	MANUFACTURER	TYPE & TOLERANCE
R-416	820 K	Allen Bradley	EB 10%
R-417	1.2 Meg	Allen Bradley	EB 10%
R-418	3.3 K	Electra	DC 1/2A 1%
R-419	5 K	Clarostat	49 Linear Pot.
R-421	33 ohm	Allen Bradley	EB 10%
R-422	1.8 K	Electra	DC 1/2A 1%
R-423	220 K	Allen Bradley	EB 10%
R-424	680 ohm	Allen Bradley	EB 10%
R-425	1 Meg	Allen Bradley	EB 10%
R-426	1.8 Meg	Allen Bradley	EB 10%
R-427	390 K	Allen Bradley	EB 10%
R-428	100 K	Allen Bradley	EB 10%
R-429	1.8 K	Allen Bradley	EB 10%
R-430	4.7 K	Allen Bradley	HB 10%
R-431	330 ohm	Electra	DC 1/2A 1%
R-432	390 K	Allen Bradley	EB 10%
R-433A	120 K	Allen Bradley	HB 10%
R-433B	100 K	Allen Bradley	HB 10%
R-434	68 ohm	Allen Bradley	EB 10%
R-435	18 K	Allen Bradley	GB 10%
R-436	180 K	Allen Bradley	EB 10%
R-437	82 K	Allen Bradley	EB 10%
R-438	47 K	Allen Bradley	EB 10%
R-439	10 K	Allen Bradley	EB 10%
R-439	330 K	Allen Bradley	EB 10%
R-442	68 ohm	Allen Bradley	EB 1/2W 10%
R-442	100 K	Allen Bradley	EB 10%
R-447	Concentric Selector Switch and 5 K Linear W.W. Pot.	Centralab	Special EMR B-02342
R-450	1 K	Electra	DC 1/2A 1%
R-451	2.2 K	Electra	DC 1/2A 1%
R-452	6.8 K	Electra	DC 1/2A 1%
R-453	12 K	Electra	DC 1/2A 1%
R-454	27 K	Electra	DC 1/2A 1%
R-501	100 K	General Radio	974RG 4S1 (Spec. 4 gang pot.)
R-502	40 K	Electra	DC 1/2A 1%
R-503	100 K	General Radio	974RG 4S1 (Spec. 4 gang pot.)
R-504	40 K	Electra	DC 1/2A 1%
R-505	100 K	General Radio	974RG 4S1 (Spec. 4 gang pot.)
R-506	40 K	Electra	DC 1/2A 1%
R-507	100 K	General Radio	974RG 4S1 (Spec. 4 gang pot.)
R-508	40 K	Electra	DC 1/2A 1%
R-509	4 K	Electra	DC 1/2A 1%
R-510	4 K	Electra	DC 1/2A 1%
R-551	100 K	General Radio	974RG 4S1 GR Pot Modified
R-552	40 K	Electra	DC 1/2A 1%
R-553	100 K	General Radio	974RG 4S1 GR Pot Modified
R-554	40 K	Electra	DC 1/2A 1%
R-555	100 K	General Radio	974RG 4S1 GR Pot Modified

SYMBOL	DESCRIPTION		MANUFACTURER	TYPE & TOLERANCE
R-556	40 K		Electra	DC 1/2A 1%
R-557	100 K		General Radio	974RG 4S1 GR Pot Modified
R-558	40 K		Electra	DC 1/2A 1%
C-1	10 mfd		Sprague	CP70B1F F106V
C-2	.0005 mfd		El Menco	CM15-501 5%
C-3	1. mfd		Pyramid	7PGIHL 4-1
C-4	.001 mfd		El Menco	CM19-102 10%
C-5	6 mfd		Sprague	CP70B1 F F605V
C-6	.01 mfd		El Menco	CM35-B 103 10%
C-7	.5 mfd		Sprague	CP54-B1 EE-504M
C-8	.001 mfd		El Menco	CM19-102 10%
C-9	.01 mfd		El Menco	CM35-B 103 10%
C-10	.47 mfd		Pyramid	7PGH3-P47
C-11	.22 mfd		Pyramid	PGH2 P22
C-12	.22 mfd		Pyramid	PGIH2-P22
C-13	1 mfd	400 VDC	Tobe	OMB-401 20%
C-14	2 mfd	400 VDC	Tobe	OMB-402 20%
C-15	Power Transformer with capacitor (Used on A or D Models only)		Raytheon	W-6854-B EMR B-00042
C-16	.01 mfd		El Menco	CM35-B 103 10%
C-17	.039 mfd		Pyramid	PGH2
C-403	.1 mfd	300 VDC	Pyramid	7EPGIH 20%
C-404	.05 mfd	300 VDC	Pyramid	EPGIH 20%
C-405	150 mmf	500 VDC	El Menco	CM15E 151J 5%
C-406	680 mmf	500 VDC	El Menco	CM19B 681K 10%
C-407	30 mmf	500 VDC	El Menco	CM15E 300J 5%
C-408	.002 mfd	500 VDC	El Menco	CM20B 202K
C-409	20 mmf	500 VDC	El Menco	CM15C 200J 5%
C-410	.01 mfd	600 VDC	Pyramid	EPGIX 20%
C-411	680 mmf	500 VDC	El Menco	CM19B 681 K
C-412	.004 mfd	500 VDC	El Menco	CM30-402 10%
C-413	20 mmf	500 VDC	El Menco	CM15C 200J 5%
C-414	150 mmf	500 VDC	El Menco	CM15E 151J 5%
C-415	.003 mfd	500 VDC	El Menco	CM30B 302K 10%
C-416	.0012 mfd	500 VDC	El Menco	CM20-122 10%
C-417	.0056 mfd	500 VDC	El Menco	CM30-562 10%
C-418	.1 mfd	600 VDC	Pyramid	7PGIM 20%
C-419	.002 mfd	500 VDC	El Menco	CM20B 202K 10%
C-420	.47 mfd	200 VDC	Pyramid	7PGIH 20%
C-421	.25 mfd	300 VDC	Pyramid	7EPGH 20%
C-422	.001 mfd	500 VDC	El Menco	CM19-102 10%
C-423	.05 mfd	300 VDC	Pyramid	EPGIH 20%
C-424	600 mmf	500 VDC	El Menco	CM19B 681K 10%
C-501	1.01 mfd	400 VDC	Efcon	MHA 1%

SYMBOL	DESCRIPTION		MANUFACTURER	TYPE & TOLERANCE	
C-502	.320 mfd	400 VDC	Efcon	MHA	1%
C-503	.101 mfd	400 VDC	Efcon	MHA	1%
C-504	.0320 mfd	400 VDC	Efcon	MHA	1%
C-505	.0101 mfd	400 VDC	Efcon	MHA	1%
C-506	3200 mmfd	500 VDC	El Menco	CM-30	1%
C-507	1010 mmfd	500 VDC	El Menco	CM-19	1%
C-508	.268 mfd	400 VDC	Efcon	MHA	1%
C-509	.0850 mfd	400 VDC	Efcon	MHA	1%
C-510	.0268 mfd	400 VDC	Efcon	MHA	1%
C-511	8500 mmfd	300 VDC	El Menco	CM-35	1%
C-512	2680 mmfd	500 VDC	El Menco	CM-30	1%
C-513	850 mmfd	500 VDC	El Menco	CM-19	1%
C-514	268 mmfd	500 VDC	El Menco	CM-15	1%
C-515	.520 mfd	400 VDC	Efcon	MHA	1%
C-516	.166 mfd	400 VDC	Efcon	MHA	1%
C-517	.0520 mfd	400 VDC	Efcon	MHA	1%
C-518	.0166 mfd	400 VDC	Efcon	MHA	1%
C-519	5200 mmfd	500 VDC	El Menco	CM-30	1%
C-520	1660 mmfd	500 VDC	El Menco	CM-20	1%
C-521	520 mmfd	500 VDC	El Menco	CM-19	1%
C-522	.123 mfd	400 VDC	Efcon	MHY	1%
C-523	.0390 mfd	400 VDC	Efcon	MHY	1%
C-524	.0123 mfd	400 VDC	Efcon	MHY	1%
C-525	3900 mmfd	500 VDC	El Menco	CM-30	1%
C-526	1230 mmfd	500 VDC	El Menco	CM-19	1%
C-527	390 mmfd	500 VDC	El Menco	CM-15	1%
C-528	123 mmfd	500 VDC	El Menco	CM-15	1%
C-529	.0400 mfd	400 VDC	Efcon	MHY	1%
C-530	.0127 mfd	400 VDC	Efcon	MHY	1%
C-531	4000 mmfd	500 VDC	El Menco	CM-30	1%
C-532	1270 mmfd	500 VDC	El Menco	CM-19	1%
C-533	400 mmfd	500 VDC	El Menco	CM-15	1%
C-534	127 mmfd	500 VDC	El Menco	CM-15	1%
C-535	40 mmfd	500 VDC	El Menco	CM-15	1%
C-551	.268 mfd	400 VDC	Efcon	MHA	1%
C-552	.0850 mfd	400 VDC	Efcon	MHA	1%
C-553	.0268 mfd	400 VDC	Efcon	MHA	1%
C-554	8500 mmfd	300 VDC	El Menco	CM-35	1%
C-555	2680 mmfd	500 VDC	El Menco	CM-30	1%
C-556	850 mmfd	500 VDC	El Menco	CM-19	1%
C-557	268 mmfd	500 VDC	El Menco	CM-15	1%
C-558	.520 mfd	400 VDC	Efcon	MHA	1%
C-559	.166 mfd	400 VDC	Efcon	MHA	1%
C-560	.0520 mfd	400 VDC	Efcon	MHA	1%
C-561	.0166 mfd	400 VDC	Efcon	MHA	1%
C-562	5200 mmfd	500 VDC	El Menco	CM-30	1%
C-563	1660 mmfd	500 VDC	El Menco	CM-20	1%
C-564	520 mmfd	500 VDC	El Menco	CM-19	1%

SYMBOL	DESCRIPTION	MANUFACTURER	TYPE & TOLERANCE
C-565	.123 mfd 400 VDC	Efcon	MHY 1%
C-566	.0390 mfd 400 VDC	Efcon	MHY 1%
C-567	.0123 mfd 400 VDC	Efcon	MHY 1%
C-568	3900 mmfd 500 VDC	El Menco	CM-30 1%
C-569	1230 mmfd 500 VDC	El Menco	CM-19 1%
C-570	390 mmfd 500 VDC	El Menco	CM-15 1%
C-571	123 mmfd 500 VDC	El Menco	CM-15 1%
V-1	5V4GA Tube	Sylvania	
V-2	5V4GA Tube	Sylvania	
V-3	6080 Tube	R.C.A.	
V-4	6AW8 Tube	Tung-Sol	
V-5	5651-W A Tube	Raytheon	
V-6	6AW8 Tube	Tung-Sol	
V-401	12AT7 Tube	G.E.	
V-402	6U8 Tube	R.C.A.	
V-403	12AT7 Tube	G.E.	
V-404	6AU6 Tube	R.C.A.	
V-405	6197 Tube	R.C.A.	
V-406	6L6GB Tube	G.E.	
D-401	IN215	Nat'l Semi Conductor	300v zener with D404 5%
D-402	IN212	Nat'l Semi Conductor	90v zener 5%
D-403	96A20	Int'l Resistor Corp.	
D-404	IN215	Nat'l Semi Conductor	(see D-401) 5%
F-1	Fuse	Littelfuse	313002 2 amp.
F-2	Fuse (Used on F Model only)	Littelfuse	313.500 .5 amp.
I-1	Pilot Light	Dialco	8-1930-121 With No. 328 lamp.
L-1	Filter Reactor	Colin Campbell	L-1855
L-401	100 μh R.F. Choke	Miller	4632
M-401	Meter	Marion	100-0-100 HS-2 Spec. micro amperes
P-1	Connector	Cannon	DPD-D 32C2-33S-1L
S-501	Range Switch	Centralab	Special EMR B-02346
S-502	Standard Gaussian Switch	Centralab	Special EMR B-02343
SW-1	Power Switch	A.H. & H.	81024-F
SW-3	Concentric Selector Switch and 5K Linear W.W. Pot.	Centralab	Special EMR B-02342
SW-401	Push Button Switch	Hetherington	C-100-P-3R
T-1	Power Transformer with capacitor (Used on A or D Models only)	Raytheon	W-6854-B EMR B-00042
T-1	Power Transformer (Used on F Models only)	Colin Campbell	L-1926
	Rack Connector (mates with P1)	Cannon	DPD-D32C2-34P-1L
	Pin Jack	E.F. Johnson	105-602-1 Red
	Pin Jack	E.F. Johnson	105-610-1 Dk. Blue
I-1	Pilot Light	Dialco	8-1930-121 with No. 328 lamp
	Fuseholder	Littelfuse	342003